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PATTERN-MAKER.

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WHICH WILL IN ALL RESPECTS MEET THE REQUIREMENTS OF THE FOUNDRY AND PATTERN-MAKING TRADES IN ALL THEIR BRANCHES.

THE STATE OF TRADE.

THE state of trade throughout the country is at present far from being satisfactory, and many workers are unable to find employment, owing to the dull times. On the other hand, the prospects, if not particularly bright, are not altogether discouraging. The recent improvement in the cotton trade in Lancashire should result in the business of that section of the country greatly improving. In most classes of machinery the exports during the present year have been in excess of those for 1903, and all this means employment in the foundries. To the end of September the value of our machinery exports was as follows, compared with the corresponding period of last year:—

	1904. £	1903. £
Locomotives	146,496	147,058
Steam Engines	182,795	167,110
Mining Machinery	70,616	51,640
Electrical Machinery... ...	47,777	35,969
Other Machinery	533,285	502,385
Ships	313,233	191,216

In shipbuilding the tonnage under construction in the various yards has increased from 906,608 tons at this time last year to 1,046,308 tons at the present time. The outlook in the iron trade is bad, and prices of pig-iron are still falling. The situation of iron and steel makers has certainly improved during the past few weeks, but this is partly due to the annual increase in the volume of trade at this time of the year.

The secretary of the United Pattern Makers' Association reports that the number of unemployed members continues to steadily increase, a percentage of just under 8.5 of the total membership of the Society now being unemployed. The secretary of the Association of Iron Moulders of Scotland reports, however, that the "idle benefit" has somewhat decreased. Finally, the reports of the Board of Trade show that the percentage of unemployed Union members at the end of September was 7.4, as compared with 6.8 at the end of August, and 4.8 at the end of September. These figures all go to show that although trade is far from satisfactory it is not as bad as it might be, and we think the prospects for the winter are by no means as black as they are painted in some quarters.

THE BRITISH FOUNDRYMEN'S ASSOCIATION.

The following papers were read at the recent Conference of this Association:—

THE STRUCTURE OF METALS.

BY PERCY LONGMUIR (Carnegie Medallist).

THE term structure may be defined as the arrangement of the various parts of a whole. In the case of metallic alloys these parts may, under certain conditions, be seen by the naked eye, but as a rule they are too minute for unaided visual recognition. Hence it becomes necessary to magnify the structure in order to determine its parts, and this magnification must be increased as the area of the parts diminishes. In other words, the finer the structure the greater the magnification necessary to resolve it. Structure is essentially distinct from the appearance shown by a fractured surface. The latter reveals only the appearance after breaking by force, such as a blow or pull, and what appear to be parts are really groups of parts more or less distorted by the force required to effect fracture. For instance, in breaking pig-iron, fracture travelling in the direction of least resistance follows the plates of graphite, and the broken surface may indicate more graphite than the mass actually contains. Or to take another case, lead, for instance; in breaking a bar of this metal it has to be bent backwards and forward many times before fracture, and the character of the fracture does not indicate that this metal is intensely crystalline.

In examining structures, mechanical disturbances are therefore avoided. Usually a small piece of metal is gently machined from the mass; this piece, one face of which must be a plane, is termed the "section," and two of these sections taken at right angles to each other are essential when studying the distribution of the various "parts" in the solid mass. The plane surfaces of the section is freed from scratches by rubbing on emery papers of succeeding fineness finishing at "000" or "0000." This face is then ready for the final polishing, which is effected by rubbing on a wet cloth lightly sprinkled with "diamontine," and finishing on kid skin containing a little rouge. At this stage the section should be quite free from scratches, and is now ready for etching. Etching mediums vary in character, but as a rule consist of very dilute acids, which, acting differentially on the various constituents of the metal, throw certain of them into greater prominence than others. In the case of pure metals the crystal junctions are more rapidly attacked than the crystals themselves.

All metals are crystalline, assuming the metal to be chemically pure; then in mass it will be built up of a series of crystals, and a section through the mass will show only the crystal junctions. The resemblance of metals to igneous rocks is now clear to all.

It has been already stated that all pure metals are in mass built up of crystals, and a section of such metal shows under a suitable magnification a series of lines which mark the crystal boundaries. Thus Fig. 1

FIG. 1.—PURE COPPER—CAST (58 DIAMS.).

represents the structure of pure copper and Fig. 2 that of pure iron, the former in the cast condition and the latter in the forged state. The size of the crystals are determined by the rate of cooling from a high temperature, thus the slower the cooling the larger and more geometrical are the crystals, and conversely rapidly cooling

results in a fine type of crystallisation, forging also producing a similar effect.

None of the commercial metals are met with in a state of perfect purity, and those familiar to the founder all contain certain elements whose presence may or may not be accidental. The purpose here is to briefly consider how these elements are

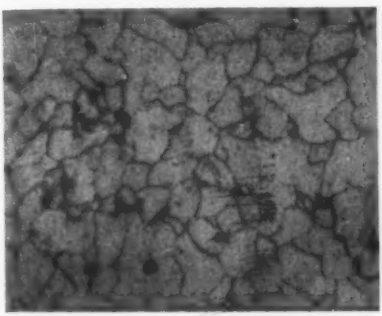


FIG. 2.—PURE IRON—FORGED (360 DIAMS.).

found in metals—in other words, their distribution and resulting influence on the mass of the metal.

Crystals on separating from their mother liquor tend to reject any impurities present in the liquid, hence on solidification of the liquid this impurity will be found imprisoned between the crystals.

If to a pure metal a second element is added, under certain conditions the element added will combine with the metal to form a compound. On cooling from a high temperature the pure crystals will separate, first ejecting to their boundaries the compound so formed. In the cold state this compound will show sectionally as a network embracing the pure crystals, as for instance in Fig. 3. As a further illustration, we may take the well-known case of sulphur and iron. If to perfectly pure iron an amount of sulphur is added, say 1 per cent., a structure roughly resembling the sketch is obtained, in which pure crystals of iron are surrounded by a network of iron sulphide. Translating this structure into the solid it will be seen that the pure crystals are more or less enveloped in a membrane of iron sulphide. Several topics for thought are here suggested, from which the following may be selected.

Pure iron, as is well known, is exceedingly ductile, rivalling copper in this respect. On the other hand, iron sulphide is exceedingly brittle, and may be readily crushed by a hammer or pestle. We have in the structure now before us two distinct entities, one a soft and tough metal, the other a hard and brittle compound. No matter how small the amount of the compound may be provided it is present in quantity just sufficient to isolate the ductile crystals, then the strength of the mass is determined entirely by these envelopes. Thus when the envelope is brittle, as in the case of the sulphide, the mass is brittle, but, on the other hand, with certain added elements, the compound formed may act beneficially on the mass by promoting either ductility or tenacity. It will be seen that the thickness of these envelopes is immaterial when they are of a brittle character, for no matter how thin they are if the crystals are isolated the mass takes the properties of the envelopes.

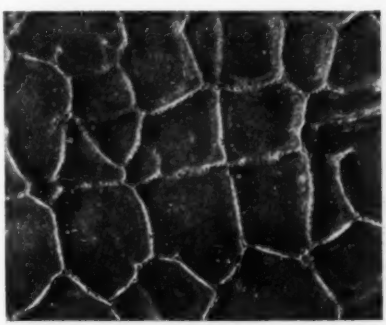


FIG. 3.—EXAMPLE OF REJECTION OF IMPURITY TO CRYSTAL BOUNDARIES (58 DIAMS.).

So far we have only considered minute additions. If additions are continued the compound formed increases in bulk, and naturally the pure metal decreases. For instance, still keeping to sulphur, when the addition reaches a content of 36.3 per cent. sulphur the whole mass will consist

of iron sulphide and possess a crystallisation characteristic of this compound.

Such a point, where the compound formed forms the whole of the structure, is termed the "saturation point." It must not be thought that all small additions to pure metals are rejected in the form of compounds to the crystal boundaries; this particular form has been mentioned first in that it throws considerable light on the action of traces of impurities.

In certain cases the addition may dissolve in the metal, forming, in the cold state, a solid solution, an example of which is found in the case of silicon. This element, added to pure iron, does not separate as a compound until a considerable amount is present. In addition to forming a meshwork, or entering into solution, the addition may separate in globular form, and the separation may represent either a compound or the element in a free state. An example of the latter is found in the graphite of cast iron and will be referred to later.

An alloy of copper and tin possesses properties entirely distinct from those of its constituent metals. When copper is alloyed with 10 per cent. tin the structure

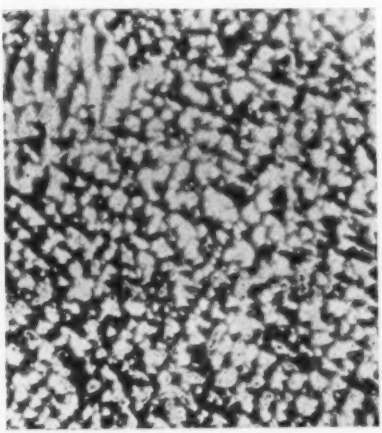


FIG. 4.—GUNMETAL (58 DIAMS.).

shown in Fig. 4 is obtained. It represents the distribution of tin—probably in the form of a compound $SnCu_4$, through a ground-work of copper. This compound is extremely hard and brittle, possesses a silver white colour, and to it is due the hardness of gun metal. Turning again to Fig. 4, the combination of properties due to the existence side by side of crystals

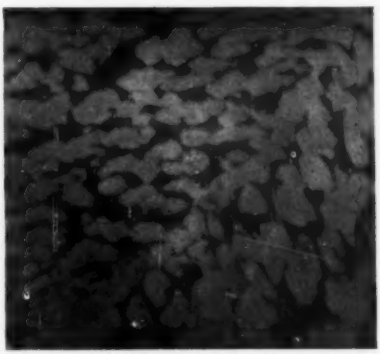


FIG. 5.—MUNTZ METAL (360 DIAMS.).

of entirely distinct properties will be appreciated, for here we have ductile copper modified by hard $SnCu_4$. As the content of tin is increased the amount of copper-tin compound increases until it forms the whole.

The next feature of interest is found in the disposal of the surplus when the addition is in excess of that required to form one compound. Turning for a moment to industrial brasses, that is alloys of copper and zinc, we find them structurally composed of two constituents, a copper zinc compound Cu_2Zn and copper. When the content of zinc reaches 34 per cent. the whole of the structure is formed of the compound Cu_2Zn. As the zinc is increased above this point a richer compound is formed Zn_2Cu. Thus an alloy containing 40 per cent. zinc and 60 per cent. copper is structually composed of Zn_2Cu. distributed in a matrix of Cu_2Zn. Such a structure is reproduced in Fig. 5 the light areas of which are the true brass Cu_2Zn, and the dark ones the compound richer in zinc, Zn_2Cu.

The alloys of iron and carbon—owing possibly to their wider application—have received a larger share of attention. Natur-

ally to this Association the alloys known as "cast iron" are of chief interest. However, before considering them a few preliminaries in connection with the influence of carbon on iron may be noted—our knowledge of this influence being due to the masterly researches of Professor Arnold. The action of carbon on iron is the most

FIG. 6.—FORGED STEEL—CARBON 0·45 PER CENT. (58 DIAMS.).

fascinating of metallurgical studies. For instance, reference to the following figure

	Carbon p. cent.	Max. Stress. Tons. pr. sq. inch.	Elongation p. cent. on 2 inches.	Reduction of area p. cent.
Mild steel	0.10	20	50	70
Tool steel..	1.0	60	5	10

shows the action of carbon on iron as illustrated by tensile tests. Between the contents of 0.1 and 1.0 per cent. C. any intermediate property may be obtained by suitably regulating the content of carbon. Commencing with pure iron each increment of carbon raises the breaking load and decreases the ductility. With further increases after a certain point the tenacity begins to fall, and falls steadily as the carbon reaches the amount met with in white cast irons. This carbon control is recognised in steel works practice, and products for specific purposes are regularly obtained, varying in some instances by only $\frac{1}{10}$ of 1 per cent. C. The structures of carbon steels should therefore possess some interest. Turning back to the pure iron (Fig. 2) it is formed as already noted of pure crystals. Crystals of pure iron are termed "ferrite," therefore the whole of the structure is "ferrite." If to this ferrite a small amount of carbon is added the carbon will combine with some of the iron to form a definite carbide Fe_3C. This carbide is intensely hard and brittle, and is known micrographically as "cementite." In annealed steels containing less than .9 per cent. carbon the "cementite" does not occur massive but is mixed with ferrite, and the combination is then known as "pearlite." Usually in these steels pearlite is composed of alternate plates of ferrite and cementite. The occurrence of a hard and a ductile constituent side by side previously noted will be again recognised.

With increasing carbon a point will evidently be reached at which the whole structure is composed of pearlite. This point has been very carefully determined by Professor Arnold at a content of 0.89 per cent. carbon, and is termed the saturation point of iron for carbon. Once this point is exceeded cementite occurs structurally free, and such steels are known as supersaturated. A steel containing about 0.45 per cent. C. will then consist of approximately equal amounts of pearlite and ferrite, as shown in Fig. 6, the dark portions of which are pearlite and the light ones ferrite. Fig. 7 shows the structure

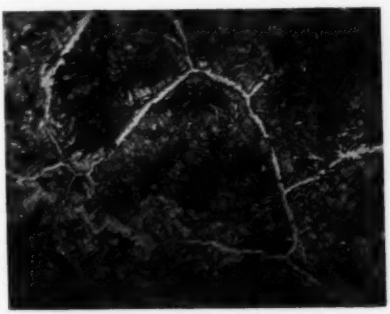


FIG. 7.—UNFORGED STEEL—CARBON 1·4 PER CENT. (58 DIAMS.).

of a steel containing 1.4 per cent. carbon, and it will be noted that the surplus carbide or cementite has been rejected to the cell walls, forming, in the solid, envelopes of cementite around crystals of pearlite.

As the carbon increases ferrite decreases, until the saturation point is reached, then

the surplus cementite crystallises round the pearlite areas in the form of cell walls.

In Fig. 8 the structure of a white cast-iron is shown, the content of carbon being about 3.4 per cent. This increase is shown

Fig. 3.—White Cast Iron (58 diams.).

in the large amount of cementite (white), and the decrease of pearlite (dark).

Grey cast irons, owing to their high content of elements other than iron, possess a complex structure, a fact readily appreciated when it is recognised that the content of iron seldom exceeds 95 per cent.

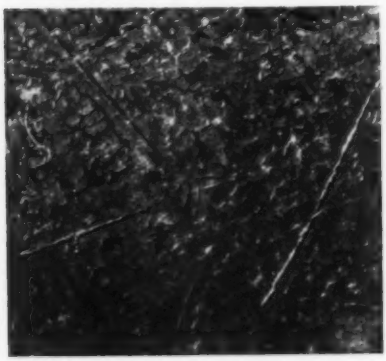


Fig. 9.—Pig-Iron (Magnified 58 diams.).

Glancing for a moment at the following analysis of an average cast iron:—

Combined carbon, 0.30 per cent.; graphite, 3.30 per cent.; silicon, 2.50 per cent.; manganese, 0.30 per cent.; sulphur, 0.06 per cent.; phosphorus, 0.40 per cent.

It will be seen to contain six elements other than iron. Of these graphite is the only one occurring in the free state. The remaining constituents are present in compound form associated with iron or other elements. Thus sulphur may occur as iron sulphide or sulphide of manganese. Combined carbon is present as a carbide of iron or under certain conditions as a double carbide of iron and manganese. Phosphorus is associated with the iron as a definite phosphide of iron. Silicon is probably present as a silicide which enters into solid solution with the iron. With the exception

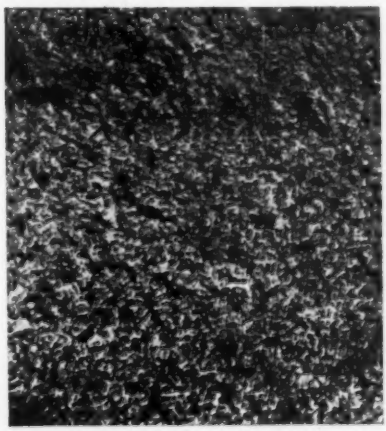


Fig. 10.—Cast Iron (Magnified 58 diams.).

of this silicide the foregoing compounds and the elementary carbon are easily recognisable under the microscope. Cementite and pearlite have been already referred to in the case of steels. Free carbon or graphite is present in pig-iron in long plates, as shown in Fig. 9. On remelting, the graphite takes a smaller and more compact form, as shown in Fig. 10. The size of the graphite flakes are determined by the casting temperature, the size of the casting, and the rate of cooling. Naturally they decrease with the thickness of the casting and with rapid cooling.

The association of iron and silicon cannot, so far as present knowledge goes, be

detected by microscopical means. As already noted, it is probably held in solid solution by the ferrite, and only

FIG. 11. - GREY CAST IRON—(MAGNIFIED 460 DIAMS.).

separates when an excess is present, probably 14 per cent. Sulphur present as

FIG. 12.—UNANNEALED STEEL CASTING—CARBON 0·36 PER CENT. (58 DIAMS.).

iron sulphide gives a light brown tint, whilst sulphide of manganese shows a light grey colour. With ordinary cast irons the phosphide of iron appears to be rejected to a eutectic of uncertain composition; eutectic may for our purpose be described as the last portion to solidify. Turning to Fig. 11, which represents the structures of pig-iron at a magnification of 460 diameters, the black graphite will be readily noted. The granular pearlite occupies the greater portion of the field. In the centre an irregular area of composite structure will be noted, this portion being the last to solidify, and containing amongst other things, the phosphide of iron.

The after treatment accorded to metals

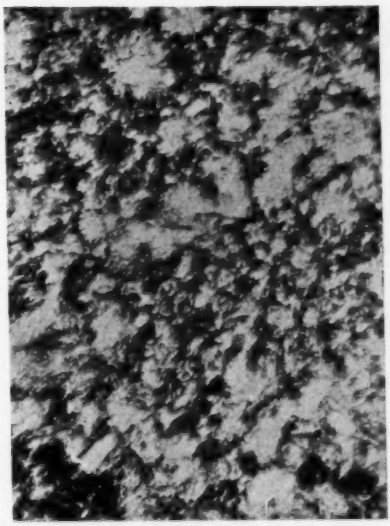


FIG. 13.—ANNEALED STEEL CASTING (58 DIAMS.).

in foundry practice may be summarised in the one term "annealing." Annealing may be divided into two classes.

1. Involving no chemical change.
2. Involving chemical change.

Of the first class, in which no chemical change occurs, we may take as an example the method followed for steel castings. These castings are heated to a certain temperature, usually about 850 degrees C., maintained there for some time and then slowly cooled, the purpose of the slow cooling being to relieve internal strains. Structurally, this change is shown in Figs.

12 and 13. It will be noted that Fig. 12 presents exceedingly sharp structure, in which the ferrite and pearlite appear almost distinct from each other. After annealing (Fig. 13) the sharpness disappears; the ferrite and pearlite appear to merge one into the other.

Annealing, involving chemical change, is most familiar in the case of malleable cast iron. These castings are originally white cast iron. We have already seen that this type of iron consists of cementite and pearlite, the former giving it such an intense hardness as to render machining an impossibility.

Cementite possesses one property worthy of note in that by suitable heat treat-

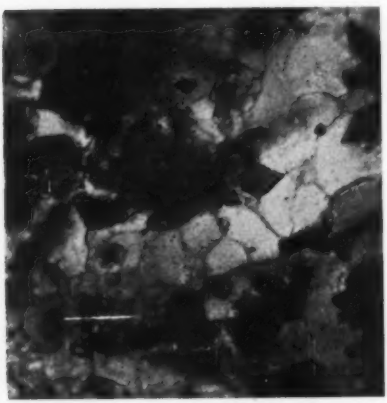


FIG. 14.—MALLEABLE CAST IRON—(MAGNIFIED 360 DIAMS.).

ment it may be decomposed into its constituents of iron and carbon. If the castings are packed in an oxidising material such as iron ore, hammer scale, and so forth, some portion of the carbon is removed. If, on the other hand, they are not packed in ore, but simply heated for the necessary length of time at a suitable temperature, the carbon is deposited in a fine non-crystalline condition. Fig. 14 shows the structure of such a material; it consists of crystals of ferrite, some pearlite and a considerable quantity of amorphous carbon.

STRENGTH TESTS OF CAST METALS.

BY W. T. MACCALL.

As the strength of castings is in many cases one of their most important qualities it may be of interest to give some account of the apparatus and methods used in testing the strength of metals.

Testing Machines.

The machines employed in carrying out such tests may usually be divided into two

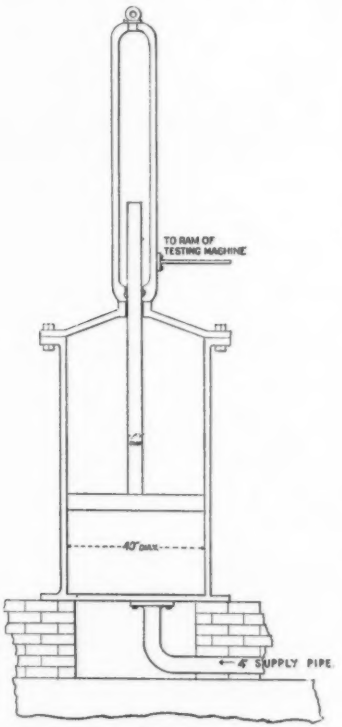


FIG. 1.

portions, one for applying a force to the test piece and the other for measuring the amount of that force. In addition, there may be other apparatus for measuring the deformation produced.

The force is usually applied by a hydraulic ram supplied with high pressure

water either by pumps or compressor or by an intensifier. The latter arrangement is adopted on the Owens College machine, at Manchester, and consists of a large cylinder containing a piston, beneath which water at a low pressure can be admitted, Attached to this is a rod which passes through a leather collar into a smaller thick walled cylinder. Mounted above the large one a pipe conveys the high pressure water thence to the hydraulic ram of the testing machine, as shown in Fig. 1, multiplying the pressure in the ratio of the sectional areas of the piston and rod. In other machines, especially for small specimens, the force may be applied by means of a screw. The apparatus for measuring the force thus applied may be either simply a pressure gauge attached to the ram, which arrangement is much liable to frictional errors, or a separate pressure measure of which the Emery machine is the best example, or else the force may be balanced by a system of levers and weights. There may be either a series of levers having the advantage of a large multiplication, and thus producing the required force with a small weight, or a single lever requiring a larger weight, but having the great advantage of simplicity. English machines usually belong to the latter class, while on the Continent the multiple lever type finds more favour. A further distinction arises according as the force is applied horizontally or vertically, but this is largely a matter of convenience of arrangement.

Fig. 2 shews diagrammatically the principle of the machine in the Owens College laboratory. It is a 100 ton Buckton Wicksteed machine of the vertical single lever-type, the force being measured by a 2 ton traveller, which can be moved along a beam 20 ft. long by means of hand gearing or by a belt. The whole is carried on a knife edge resting on a flat steel plate carried by four cast iron columns. From a second knife edge attached to the beam hangs a shackle, which may either apply a pull to the upper end of a specimen in a tension test, the lower end being fastened to the tension head attached to the ram, which is placed under the machine, or else this shackle may be attached by four long rods to a plate A balancing the pressure produced in a specimen C against the under side of a plate B attached to the ram, as shown in Fig. 3. This latter arrangement is also used for cross breaking, the specimen being supported on two knife edges on plate A, while plate B produces a down-

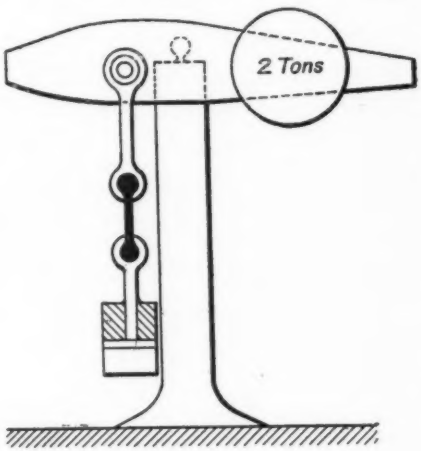


FIG. 2.

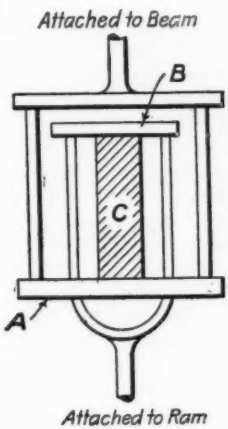


FIG. 3.

ward force at its centre through the medium of a rounded bar.

Modes of Testing.

Considering first cast-iron, as it is the cast metal most largely used, the various tests applied to it are the following :—(1.) The most usual test is the cross-breaking test, in which a uniform bar is supported near its ends and loaded in the middle, the load being increased gradually until fracture occurs, the deflection at the centre of the bar, being sometimes noted. The two standard forms of this test are a bar 1 in. square on supports 1 ft. apart; and a bar 2 in. by 1 in., with the 2 in. side vertical, on supports 3 ft. apart. For equal strength the weight required to break a bar under the latter conditions is greater than that required in the former case in the ratio of 4 to 3, by the ordinary theory of beams. This theory, however, does not apply strictly to cast-iron, but this point will be further treated later on. The bars are rough cast bars, and owing to the greater strength of cast-iron to resist crushing than against a pull, failure actually commences on the lower side where the metal is in tension.

This cannot be seen in an actual test, because the bar breaks right across practically instantaneously. The fracture should be free from all flaws, and the texture and colour of the graining give a very good idea of the quality of the iron apart from the actual strength as shown by the size of the load applied.

Ordinary cast-iron should stand over 2,000 lbs. at the centre of 1 ft. span on a bar 1 in. square, according to the Admiralty Specification. This corresponds to 24 cwt. on a 2 in. by 1 in. bar on 3 ft. centres, on which size the higher load of 30 cwt. is usually specified, corresponding to over 2,500 lbs. on the smaller bar. Some results of actual tests are given below.

Cast-iron Cross-breaking Tests.

Bars 2 in. by 1 in. on 3 ft. centres :—
30.2, 26.4, 25.8, 25.6, cwt.
27.2, 24., 22., "

Bars 1 in. sq. on 1 ft. centres :—
2,370, 2,330, 2,640, 2,730, 2,570 lbs.
2,620, 2,330, 2,930, 2,730, 2,770, 2,840 lbs.

These results placed in the same line are from bars cast from the same mixing.

Another test which is applied to cast-iron is a direct pull. For such tension tests, a bar of uniform section cannot be used, as is often done in the case of wrought iron or mild steel, for the inferior ductility of cast-iron would cause fracture at the point where the machine gripped the specimen, and the test would, therefore, give too low a value for the tensile strength.

In consequence of this, the test piece is turned as in Fig. 5, with a flat head at

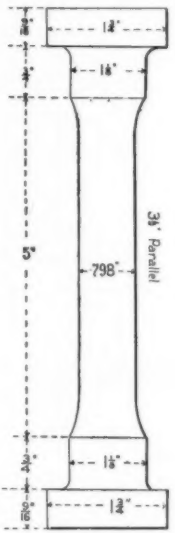


FIG. 5.

each end, which rests on split grips attached to the machine. The next portion is turned to fit the grips easily, and after this the section is again diminished to ensure fracture occurring in the middle portion of the specimen. One standard form is shown; the diameter is made .798 in., so that the area shall be exactly half a square inch, to simplify the calculation of the stress in tons per square inch. The specimen may also be made .564 in. diameter in the middle, *i.e.*, quarter of a square inch, the $1\frac{1}{8}$ diameter, becoming $\frac{3}{4}$ in. diameter, and the other dimensions being correspondingly reduced. As cast-iron has a very small elongation there is no

necessity to provide a length of uniform cross section for the measurement of elongation, so that instead of the diameter being uniform for two or more inches (as in the above cases), it may be gradually and continually diminished from each end to the centre, as shown in Fig. 4. In all cast-iron specimens for tension tests it is essential that all corners should be rounded,

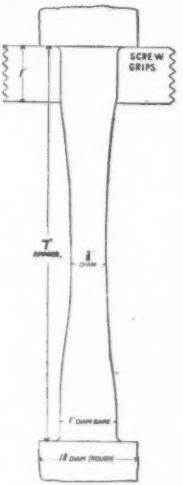


FIG. 4.

and changes of section made as gradually as possible; this particularly applies to the junction of the head with the neck of the specimen, as unless this is well rounded, the head will break off, spoiling the test. This is due partly to the fact, well known by foundrymen, that in a casting made with sharp corners the crystals arrange themselves at an angle forming a line of weakness, and partly to the low ductility of cast-iron, whereby (even if the crystalline structure were homogeneous), there would be an excessive stress at any sudden change of section. On the other hand, the rounding must not be great, as this would prevent the head bedding down on the grips.

The highest recorded tensile stress for cast-iron is slightly over 18 tons per square inch, and a specified stress of not less than 12 tons per square inch is a severe test, ordinary qualities coming out at about 8 tons per square inch. In the following table of results, the first column denotes the number of specimens of which the other figures give the average breaking loads, etc.:—

Tension Tests of Cast-iron.

No.	Diameter.	Area.	Load.	Stress.
	Inches.	Sq. inches.	Tons.	Tons/sq.in.
13	.624	.307	3.89	12.72
3	.609	.291	5.05	17.23
12	.798	.500	6.85	13.7
2	.782	.481	4.21	8.77
3	.636	.318	5.09	15.97
1	.635	.317	3.91	12.33

The first set of figures in the table alone refers to test pieces of the tapered form (Fig. 4) of a good quality; none of these 13 specimens broke under a less stress than 12.1 tons per square inch. The next set of figures gives the result of 3 tests on specimens cast from scrap iron of about the same quality, showing an increase of strength of about one-third due largely to the remelting; there was at the same time an increase of hardness making the metal more difficult to machine. Next we have 12 specimens of the parallel form (Fig. 5), giving a higher average than the first set but less uniform, one breaking at 11.8 tons per square inch, though no others were below 12 tons per square inch.

Then we have two samples of the ordinary grade of cast-iron. The last two sets of figures show the influence of flaws, the four specimens being of the same iron, but a small flaw in one of them reducing its apparent strength to 12⅓ tons per square inch.

A third test, but one less usually applied to cast iron, is a crushing test. Cast-iron will stand a far larger stress in compression than in tension, so that much larger loads are required to break a test piece of the same size in the former case. In such tests the form of the specimen is of the highest importance, for if the length be considerable, compared with the diameter, failure will be by bending not by crushing only, and though allowance can be made for this by means of Hodgkinson's or Gordon's formula, this is scarcely satisfactory. When the length is so short that fracture is caused almost entirely by crush-

ing, the mode of failure is by shearing at an angle with the direction of pressure which varies somewhat, but is in the neighbourhood of 35 degrees; the sliding of the pieces over one another produces a polish on the fractured surfaces.

If, instead of being too long, the test piece is very short, this natural angle of shear will be interfered with and the rupture stress raised, so for a satisfactory test the length should be two to three times the diameter, though a length up to five times the diameter may be employed without seriously affecting the strength. In addition to being of the right length and turned to a uniform diameter, the specimen must have its ends flat and exactly at right angles to its length, and the plates between which it is crushed must be kept parallel; in addition, the load must be applied centrally, and unless all these conditions are fulfilled, bending moments will be produced, which will cause fracture at too small a load. Results of tests on 1 in. diameter, and $\frac{3}{4}$ in. diameter cylinders are given below, in each case the length was five times the diameter. Such specimens usually fail by shearing as described, rupture taking place suddenly, the broken pieces flying out violently, unless stopped by guards; fairly often, however, considerable bending occurs, but rupture is again sudden.

Compression Tests of Cast-iron.

No.	Diameter.	Length.	Load.	Stress.
	Inches.	Inches.	Tons.	Tons/sq.in.
8	1.01	$5 = d \times 5$	34.5	42.7
8	.75	$3\frac{3}{4} = d \times 5$	20.2	45.0

Test pieces for tension or compression are usually cast in one with actual casting for use from which they are cut, broken off, and turned to the required dimensions. Bars for cross breaking tests are cast separately as a rule, but should be from the same ladle as the castings of whose quality they are intended to be samples; they are tested in the rough, without any machining, whereas tension and compression specimens are always turned to the required dimensions.

Turning to other metals, cast steel is usually tested in tension, the form of specimens being either that first described for cast-iron or else a form turned to $1\frac{1}{4}$ in. diameter for about 3 in. to fit in roughened grips, then with a rounded shoulder down to a smaller diameter (say $\frac{7}{8}$ in.) for a length of at least 2 in. and another $1\frac{1}{4}$ in. diameter piece for gripping at the other end. Cast steel differs from cast-iron in having an appreciable stretch, so the elongation per cent., after rupture, is usually measured on a length of 2 in. or longer if the specimen allows.

As first pointed out by Mr. J. Baiba, in 1880, this length should be proportional to the diameter for results to be comparable, but this is not always convenient. Prof. Unwin, in a recent paper before the Institution of Civil Engineers, has shown a method by which differences thus caused may be eliminated, but it is somewhat too complicated for commercial testing, and can scarcely be applied if the tested length of the bar is only two inches; in any case, it is of much more importance in mild steel tests, where the elongation is very large and need not be considered for cast steel in the ordinary cases. The fracture of cast steel sometimes shows bright coarse crystals, and at other times is of a granular character, and its ultimate strength varies between wide limits while its elongation may be anything up to about 25 per cent. on 2 in. A table of test results is appended:—

TESTS OF CAST STEEL.

No.	Diameter.	Area.	Tons.	Load.	Stress.		Elongation.	Contraction of area.
	Inches.	Sq. inches.	Yield.	Maximum.	Yield.	Maximum.	Per cent.	Per cent.
1	.568	.253	—	7.54	—	29.8	4 on 2 in.	3.2
2	.567	.252	—	6.15	—	24.4	16 ,,	22.4
1	.785	.484	—	13.21	—	27.3	24 ,,	23.8
2	.780	.478	—	15.66	—	32.7	144 ,,	—
1	.809	.514	—	12.90	—	25.3	nil.	nil.
3	.780	.479	7.28	14.22	15.2	29.7	14.3 on 8 in	15.4

For cast brass and gunmetal, or bronze also, the usual test is the tensile one, because of the expense of casting the large bars used in cross breaking, and further, because for these metals a test in tension gives sufficient evidence as to the strength of the material, and tells more about its quality than either of the other tests.

The form usually adopted is similar to that first described for cast-iron tension tests (Fig. 5), but of the smaller size, and the middle portion allows two or three inches to be marked on the bar for observing the elongation. In addition, the load at which the first visible stretch takes place is noted, and from this the "stress at yield" is calculated.

As the term "gunmetal" covers alloys of widely differing compositions, it is only natural that its strength and ductility should vary between wide limits, as the appended figures show:—

The ordinary theory of beams assumes that Hooke's law, that strain is proportional to stress, is obeyed throughout, and further, that the value of Young's modulus, which expresses this relation quantitatively, is the same for tension and compression. This theory gives satisfactory results when applied to wrought iron or mild steel, but it has long been known that when applied to cast-iron, it gave results for the cross breaking strength as deduced from the tensile strength which were far too low, and necessitated the use of empirical constants ranging from 1.5 to 22 in order to reconcile it with the actual results of tests. But for cast-iron, neither of the above two assumptions holds good, and in this lies part of the explanation of the derivation from theory. Mr. Clark, therefore, performed a series of tests on a set of castings which were made as closely as possible of the same iron, being all cast together with all possible precautions.

TESTS OF BRASS AND GUNMETAL.

GUNMETAL.

No.	Diameter. Inches.	Area. Sq. inches.	Tons. Yield.	Load Maximum	Stress. Yield	Stress. Maximum.	Elongation. Per cent.	Contraction of area. Per cent.
14	.511	.205	2.55	3.48	12.2	16.9	10.4 on 3 in.	11.4
1	.708	.500	—	13.74	—	27.5	31.5 on 2 in.	—
1	.708	.500	—	6.45	—	12.9	7.5 ,,	—
2	.571	.256	—	3 43	—	13 0	5 ,,	6

BRASS.

4	.519	.217	1.20	.2'8	5.6	10.3	14.4 on 3 in.	20.6

The brass fracture generally shows a crystalline structure with the crystals radiating from the centre, while gunmetal is of a more homogeneous granular type. Brass is low in strength, about 10 tons per square inch, and consequently is not used where strength is of importance, but largely for ornamental work. To return to the already mentioned fact, that the ordinary theory of beams does not apply to cast-iron; this has been discussed and partly explained in a paper by Mr. E. Clark,* and the outline of this paper together with certain other considerations will be given here.

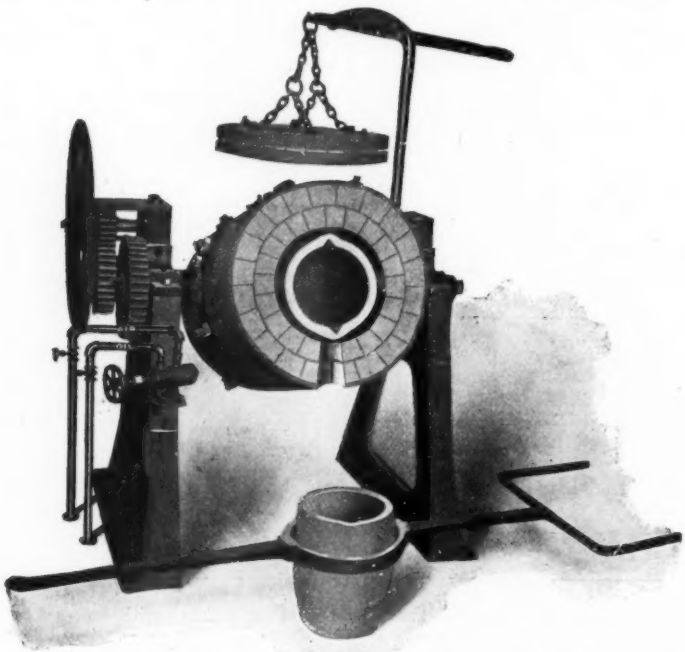
He first found experimentally the law connecting strain and stress for this particular of cast iron, both in tension and compression, and then applied this to the calculation of the breaking loads in cross-breaking tests on brass of rectangular, circular, and square section, the last being placed, not flat, but on one angle with suitable supports. These calculated results were then compared with actual tests on bars prepared at the same time as the other test pieces. Working in this way the following results were obtained. If we represent the calculated breaking load by 100,

* Proc. Inst. C.E. Vol. CXLIX., Part 3.

then the actual breaking loads were, for rectangular bars, 175 by the ordinary theory, 124 by the amended theory; for square-on-angle bars 220 and 140 respectively, and for circular bars, 170 and 114.

The results for circular bars are closer to the actual results than is to be expected, owing to these bars giving way under unusually small loads. It will be seen that while the gap between the theoretical and actual loads has been greatly reduced, there still remains a very considerable difference to be explained. We investigated at Owen's College the effect of applying to Mr. Clark's results a form of the equation between stress and strain different to that used by him or to any which he mentioned, viz.: $f = C\alpha^n$, C and n being constants, but the differences thus produced were inconsiderable. He himself mentions two sources of error, and a third may be in the possibility of the value which he obtained for the ultimate tensile strength being too low; tests on bars of the tapered section shown would throw light on this. The case of the square-on-angle bar is most interesting, both because it shows the widest divergence between theory and practice, and because of the theoretical strength of such a bar can be increased by removing some of the material from the tension corner.

The greatest increase is produced by removing a depth equal one-fifth of the semi-diagonal of the bar, and more than two-fifths can be removed without bringing the strength below that of the original bar. Unfortunately, neither Mr. Clark, nor, as far as I know, anyone else, has done any experiments as to how far this is borne out in practice; such experiments would be fairly simple to carry out and might throw interesting light on the still obscure question. In conclusion, I would like to point out that while strength tests in themselves cannot give a proper insight into the qual-



THE STEELE-HARVEY FURNACE IN POURING POSITION. BUILT BY J. W. JACKMAN & CO.

ity of cast metals, they are, since it is the physical properties that determine the value of materials, of the chief importance, and further furnish the readiest means of testing castings of every description.

—o—

THE STEELE-HARVEY MELTING FURNACE.

One of the latest melting furnaces for brass and alloys, and one that has much to commend it, is just being erected at the works of Mr. Jonas Wells, of Keighley, by Messrs. J. W. Jackman & Company, of 39, Victoria Street, London, who are the selling agents.

The Steele-Harvey Furnace in Melting Position. Built by J. W. Jackman & Co.

The furnace is shown in the annexed two views, and comprises an outer shell with lined bottom and sides with a double row of fire-brick, and an air space between the inner wall of the fire-brick lining and the crucible. The crucible rests at the bottom on a square graphite block, against which the flame is played, and circulates entirely around the crucible. The furnace is swung between two upright trunnions, and is under control of the operator by a mechanical device operated by gear wheels and connections, which enables the operator to tilt it at an angle desired, enabling it to be placed in a pouring position within his full view and control. The furnace is entirely above ground. The burner is operated with both oil and air, and is controlled by the main piston valve, which operates with a needle point at the extreme oil outlet, thereby giving a vapourising effect and freer circulation of oil and air. The crucible is always retained within the furnace, thereby losing no

heat in cooling off, and is secured in position by a wedge-shaped fire-brick, and is never taken out, thereby extending the life of the crucible.

The furnace occupies a floor space about 3 ft. 6 in. by 4 ft. 6 in. A special large lip crucible is recommended. The furnace in shipping order weighs from 1,700 to 2,600 lbs. gross. The burners consume from 10 to 15 cubic feet of air per minute, and operate under from 40 to 60 lbs. pressure. The greater the air-pressure the more economical use of oil. The sizes are as follows :—

a.	20	heats	per day	and 2,400	lbs. of Metal.
b.	15	,,	,,	2,700	,, ,,
c.	9	,,	,,	3,200	,, ,,
d.	3 to 5	,,	,,	4,000	,, ,,

The lid is lifted with a crane attachment, and is moved aside in charging and then moved back in place to remain until pouring. The furnaceman is not exposed to danger, or waste heat, as in a coke furnace, and one man attends to four or five furnaces. The lining of the furnaces is composed of ordinary wedge fire-brick, and will stand about 500 heats.

It has been proved by test that in daily foundry works this furnace will melt 100 lbs. of metal with 1½ gallons of crude fuel oil, and that with the patent burner from 5 to 15 heats per day are secured, with a waste not exceeding 1½ per cent. of mixture. It is claimed that the flame, which does not bear directly on the crucible, ensures from 20 to 50 heats for the larger sizes, and 60 or more for the smaller sizes.

—o—

THE ASTON BRASS & ENGINEERING COMPANY, LIMITED, has been registered with a capital of £10,000.

HAYWARD-TYLER & COMPANY write that in last issue we printed their name as a limited company in noticing their removal. They inform us that they are a private company.

MESSRS. CUTTING BROTHERS, LIMITED, electrical and mechanical engineers, of Derby, will shortly build new works at Stamford, they having just secured a convenient site in that town.

ECONOMY IN FOUNDRY COST-FINDING.*

BY JAS. C. LOUGHREY.

WHEN we speak of economy in cost-finding, we do not mean only that which implies the least expenditure. Webster, in defining economy, says: "That management which expends money to advantage and incurs no waste; frugality in the necessary expenditure of money. It differs from parsimony, which implies an improper saving of expense." To produce without finding the cost, is "improper saving of expense" and not economy. To find the cost of casting requires expense; to educate our children is also an expense, but who in this age looks upon it as unnecessary? Perhaps some children may not yield a profit on such expenditures, but that is the fault of the child or the instructor, and not the education. It may be that for some foundrymen cost-finding has not been a profitable investment, but that is the fault of the system or the one who executes it, and not the knowledge of the cost of their castings.

We will not confine this article to the subject of economical methods of determining the cost of production, but to show that it is economy to find definitely the cost of production, regardless of the expense involved, and endeavour to prove it to be "that management which expends money to advantage."

Now, a faulty system may leave you in the dark; a miscalculation may make a leak in the profits that is hard to trace. Your margin of profit is in your books, and it is not only necessary for you to know whether you are losing or making money, but to know where you are making, or if losing, to get some idea how to stop the loss. Even though making money, there may still be some leaks which, if stopped, would increase the profits. A good system of bookkeeping, properly executed, is worth much to you. By this we mean sales and purchase ledgers with a cost system so interwoven that with each month's balance

*Abstract of paper read before the American Foundrymen's Association.

they produce a systematic comparison of accurate detail costs, of each casting, each job or order or each class of castings, as the case requires.

The managers who look upon system as unnecessary red tape, are not managers of the shops paying the largest dividends. Their systemless methods require the most of their time attending to minor details, which under a proper system would be better cared for by an assistant at 30s. a week.

We may be able to keep a small business afloat without this systematic detail, but the same displacement that carries a small boat will not bear up a large vessel; if we aspire to a greater number of large prosperous foundries, we must set sail to catch the breeze, systematic accounting, that will waft us on. You improve and repair your riggings, put in various kinds of moulding machines, etc., but your way of accounting has run on and on without oil or repairs, until the old system is breaking down under the load. In fact, if the bookkeeper asks for an extra card or form with which to patch it up, it is allowed only after considerable persuasion, and an extra clerk is not to be thought of.

Why continue this "improper saving of expense"? We have our organisations for everything except accounting, why not a section for cost-finding?

Repair and improve the worn-out methods, stop the friction, and you will be surprised at the amount of power saved and the ease with which your business will run. The advantages of such an organisation would be many. Large corporations pay their accountants large salaries for their ability to systematise. Of course, the volume of business done by the majority of our foundries will not admit of a man of this ability as the head of their accounting, but some such method as suggested would be of assistance in the betterment of foundry accounting, or an organisation of this kind could have in its employ a man of this ability, to assist its members in formulating better systems for the handling of their business.

The point we have tried to make is this, that if you are trying to increase your profits by the little you can save by producing without ascertaining the cost, and just what constitutes that cost, you are working with too short a leverage; dividends are not made in that way. We are well aware that many are aroused to the need of this knowledge, but few are fully awake to the fact that the expense involved in finding the cost means an increase and not a decrease in the dividends. An example of this is a manager who employed boys to gather nails out of the sand, and to straighten them for further use. About this time an article appeared in which it was shown that nails were so cheap that if a carpenter receiving 10s. a day dropped one it was cheaper to take a new one out of his pouch rather than take the time to pick it up. Needless to say, the boys were put at other work.

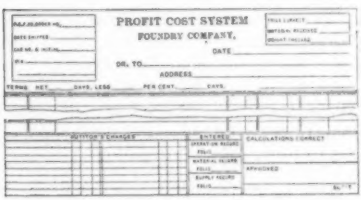
The Kind of a System.

The writer has read many articles upon foundry-costing and with but one exception the subject was treated upon an estimating basis. The day of estimated costs departed in company with "large profits." The small margin of to-day demands accuracy and reliable detail. The costs are of small value which do not represent the exact expenditure as shown by the ledger balance; in other words, ledger-balance costs. With these we not only know that nothing has been overlooked or omitted, but that no clerical errors have been made. With estimated costs there is no proof against any of these errors and no accurate profits can be based upon them.

I wish to correct the prevailing impression that a ledger-balance system is an expensive one. If accuracy was required in many of the "come-somewhere-near" systems, the ledger-balance system would in every instance require the least expenditure of both labour and money. With a ledger-balance system you cannot say $6 \times 4.25 = 15.50$ and never know that that job cost you £10 more than your figures represent; everything must fill out a certain place, and if too much or too

little, you soon find it out. With a system of this kind, the chief desideratum of every entry is to know the cost of production. Each book, form and card used have in them the threads, which are automatically woven into the aggregate cost, which consist of as many different colours of thread or detail as required.

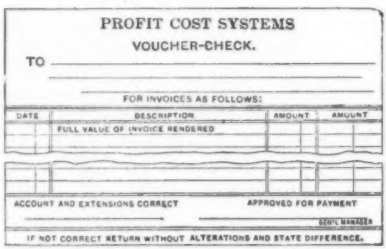
The first step towards a ledger-balance cost system is the voucher method, for the handling of accounts payable; with this we include petty cost expenditures and payrolls, in fact, all money paid away. A voucher system can be used without a ledger-balance cost system, but the reverse is not desirable. Forms "A" and "B" make a very satisfactory voucher, plain and easily understood, yet giving all necessary information. Form "A" always accompanies an order with a request that invoice be rendered upon the accompanying blank. This is printed in copying ink, enabling the shipper to make an impression copy for his records, thus avoiding extra manifolding at either end of the line. When



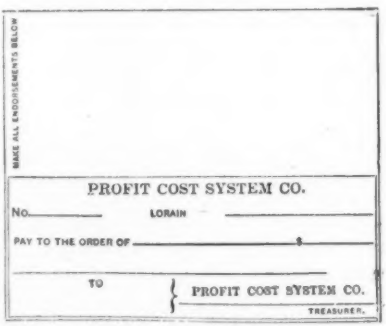
FORM "A" (FRONT).

FORM "A" (BACK).

received from the shipper as an invoice rendered, it shows the order number upon which shipment of material, charged thereon, was made, date, car number and route of shipment. This is first used by the buyer, who checks the price, makes note of shipment upon his copy of the order on which shipment applies and inserts auditor's charges. It is then passed to the receiving clerk, who checks the weight or quantity and marks date material is received. It now goes to the bookkeeper, who checks the calculations, and after numbering it, makes the necessary entries. It is then approved by the superintendent and passed to the typewriter, who fills out a corresponding form "B" and returns both to the bookkeeper or auditor for certifying Form "B." Form "A" and Form "B" are now



FORM "B" (FRONT).



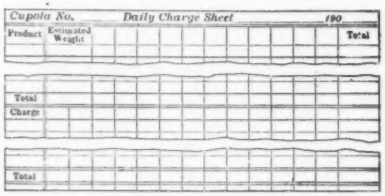
FORM "B" (BACK).

folded together and given to the general manager, who approves for payment Form "B," which is then passed to the treasurer for payment. Form "A" is now filed away and when Form "B" is returned through the bank, it is filed with Form "A"; thus not only making a complete

record, but also rendering it impossible for the paying away of any money without the knowledge of the proper officials. Any number of "A" forms can be stapled and made up into one voucher, cutting off at line of auditor's charges, all except the last one, which bears charges and approval for all.

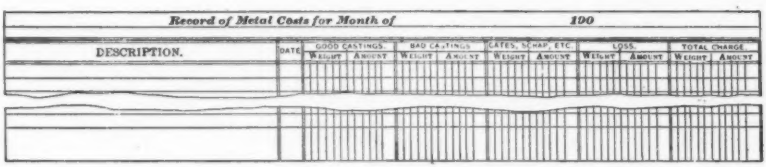
A book which is a purchase ledger, voucher record, and transfer journal combined, and known as an "Operation Record," is a labour saver, and if properly designed, a very satisfactory arrangement for any foundry business. This makes a complete record of accounts payable and contains place for the detailing of the cost of the various productions. A separate ledger is required for the detailing of material in stock, that is, pig-iron, coke, coal, sand, limestone, etc. Chaplets, facings and moulders' supplies of all kinds, should be charged to an account known as "store" or "supplies," and put in charge of someone who delivers same to moulders as required, and makes report of all such deliveries, that said account may be credited and charge made against proper job.

All pig-iron and coke of course is weighed when delivered to cupola and reported daily. Form "F" is designed for this purpose, where a variety of castings are made, requiring an entirely different mixture. The lower part instructs the cupola men how



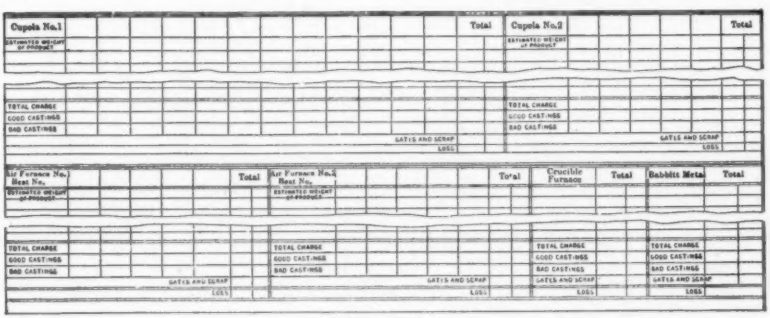
FORM "F."

the iron is to be charged into the cupola, and the top part gives the amount and kinds of iron charged for each job or grade of castings. Where the total cast requires practically the same mixture of iron, a more simple form answers this purpose. Forms "K" and "L" are used in compiling the cost of metal, cupola loss, bad casting loss, etc.



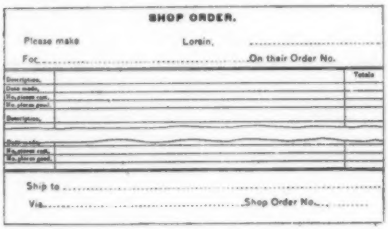
FORM "K."

When an order is received, a shop order, Form "M," is made, and customer's order



FORM "L."

stamped "entered" shop order No. — which is then filed and ordinarily not re-


SHOP ORDER.

Please make Lorain,

For On their Order No.

Totals

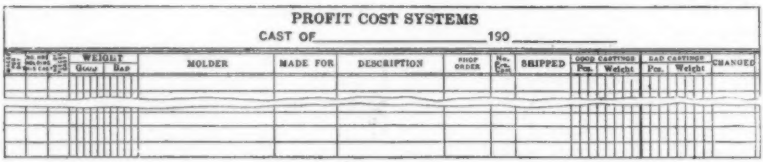
Ship to

Via Shop Order No.

FORM "M."

ferred to again. Upon Form "M" is recorded daily the number of castings made from each pattern, and later the number which proves good. A shipping form is made in carbon at the same time Form "M" is made out, ruled as to record dates and quantity of shipments made. When an order has been filled, Forms "M" and "M1" are bound or filed together in numerical order. There is also a shop order card for following the work through the shop, made from the original order, for each pattern, showing the number of pieces and kinds of metal required. Form "O" is a daily record of all castings made, the information for which is received by means of the shop cards. With this record is made a carbon copy for the weigh-master's or cleaning room's report of castings.

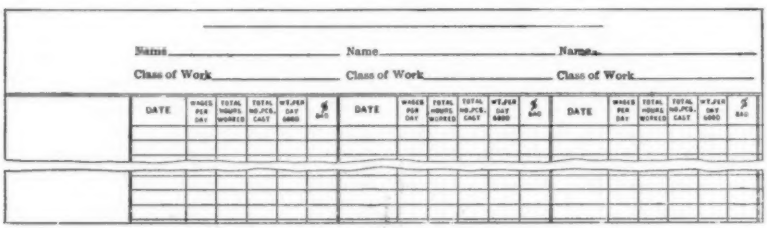
From Form "O" is secured information for Forms "K," "L," "M," "N" and "P." Form "P" is designed for a moulder's individual record, which by taking the average per week for each moulder, as recorded by Form "O"; each "P" form is printed on each side and so will accommodate the record of six moulders for one


PROFIT COST SYSTEMS

CAST OF 190

No. one	No. two	No. three	WEIGHT Gross	WEIGHT Bad	MOLDER	MADE FOR	DESCRIPTION	SHOP ORDER	No. Pcs. Cast	SHIPPED	GOOD CASTINGS Pcs.	GOOD CASTINGS Weight	BAD CASTINGS Pcs.	BAD CASTINGS Weight	CHANGED

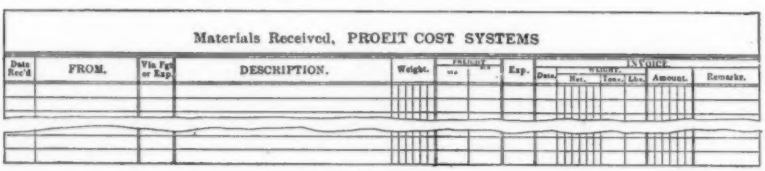
FORM "O."


Name Name Name

Class of Work Class of Work Class of Work

DATE	WAGES PER DAY	TOTAL HOURS WORKED	TOTAL NO. PCS. CAST	WT. PER DAY GOOD	% BAD	DATE	WAGES PER DAY	TOTAL HOURS WORKED	TOTAL NO. PCS. CAST	WT. PER DAY GOOD	% BAD	DATE	WAGES PER DAY	TOTAL HOURS WORKED	TOTAL NO. PCS. CAST	WT. PER DAY GOOD	% BAD

FORM "P."


Materials Received, PROFIT COST SYSTEMS

Date Rec'd	FROM.	Via, Frt. or Exp.	DESCRIPTION.	Weight.	Packing No.	Packing Wt.	Exp.	INVOICE Date.	INVOICE Weight Net.	INVOICE Weight Tons.	INVOICE Weight Lbs.	INVOICE Amount.	Remarks.

FORM "C."

year. This information could be conveniently kept in card form if preferred, but the sheet has some advantages over the card.

Form "C" makes a desirable receiving

The Result Obtained.

Time will not permit a thorough explanation of a ledger-balance system, and we will now refer briefly to the results obtained by such a system. This can best be done

PROFIT COST SYSTEMS _____ OPERATIONS, for Month of _____ 190_____

	THIS MONTH			LAST MONTH			TO DATE			LAST YEAR, TO DATE		
	Pounds	Price	Amount	Pounds	Price	Amount	Pounds	Price	Amount	Pounds	Price	Amount
Stock,												
Made,												
Total,												
Used,												
Balance,												
Sold,												
Defective Lots,												
Prices Rec'd,												
On Hand,												
Total,												
Profit,												

FORM "T."

record for use in connection with Forms "A" and "B." The part shown is for

PROFIT COST SYSTEMS CO.

COST SHEET for Month of.....

	THIS MONTH		LAST MONTH		TO DATE		LAST YEAR
	No. Pcs.	Avg. Lbs.	No. Pcs.	Avg. Lbs.	No. Pcs.	Avg. Lbs.	TOTAL Lbs.
	AMOUNT	AVERAGE	AMOUNT	AVERAGE	AMOUNT	AVERAGE	AVERAGE
MATERIAL							
Metal,							
Furnace Loss,							
Gal Cooking Loss,							
Melting,							
Gates and Sprue Loss,							
Total,							
DIRECT CHARGES Molding Sand,							
Core Sand,							
Brick							
Accessory Castings,							
Core Oven Gas,							
Total,							
MOLDING AND CLEANING Molding Labor,							
Core "							
Direct "							
Cleaning "							
General "							
Total,							
SPECIAL CHARGES Machine Work,							
Defective Loss,							
Special Expense,							
General Charges,							
Total,							
Total Cost,							
Gasoline Labor,							
Total Hand Account,							
	POUNDS	PER CENT.	POUNDS	PER CENT.	POUNDS	PER CENT.	PER CENT.
Good Castings	Lbs.		Lbs.		Lbs.		
Furnace Loss,	"		"		"		
Bad Castings,	"		"		"		
Gates and Sprue,	"		"		"		
TOTAL CHARGE,	Lbs.		Lbs.		Lbs.		

FORM "S."

local receipts; a very convenient arrangement is to have one part of the book for local and another part with a little different ruling for carload receipts, instead of separate books.

by a cost sheet, Form "S." The number of these sheets, each to represent a different job or product, are without limit, and can be modified to suit any class of work. Separate exhibit sheets are made for melting cost, core oven cost and general charges; showing the details for the aggregate of these charges, which are prorated over the different products. The item "general charges" embodies salaries and office expenses, laboratory, taxes, insurance, water, light and power, crane service, moulder's supplies, etc. Form "T" is the final or earning statement, one of which is made for each cost sheet, and which you will note makes, identical with the cost sheets, a comparison with the preceding month, year to date and previous year to date.

The profit shown thereon monthly is exactly what will be shown by the ledger at the close of the year. In fact, each month is as much the close of the year as is the twelfth month, so far as the books and earnings have to do with it. Supplies, fuel and pig-iron are inventoried whenever the stock is low and product on hand checked monthly. The proper checking out of Form "T" reveals any errors in billing, either in calculations or weight, or the failure to bill any shipment.

With a ledger-balance system each item, card, book, form, or whatsoever is a part

of the whole and will form the grand results without any friction or commotion so long as each interested party performs his or her part, and this in itself prevents carelessness upon the part of any individual. All forms requiring the workman to perform clerical work should be eliminated, and all entries should be so connected that no matter where you pick up a thread of information it can easily be followed to the start or finish.

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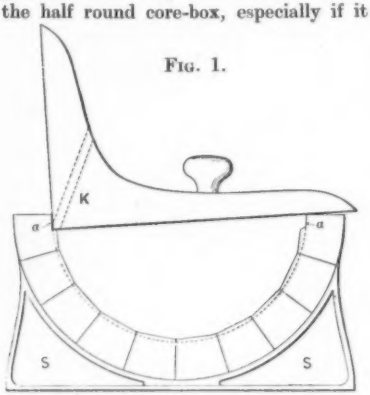
PATTERN-MAKER'S CORE BOX PLANE.

One of the things which help to keep a pattern-maker busy and not over happy is the half round core-box, especially if it is

Fig. 1.



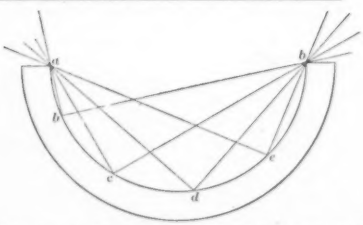


Fig. 2.—A Pattern-maker's Core Box Plane

a good size. There is usually considerable guesswork about it unless there is a boring-bar arrangement, and that isn't found very often. Many pattern-makers take their tri-square and saw it back and forth in the core-box to see if it is half round or has high spots. This is because a right angle (or 90 degree) triangle will always touch a semi-circle at three points, namely, the two ends and a point on the circumference. Speaking of geometry, an angle drawn through the ends of the diameters of a semi-circle and touching its circumference is a right angle. This can be seen in Fig. 2, where the angles *a b b*, *a c b*, *a d b* and *a e b* are all right angles, being drawn according to the conditions named.

A neat application of this principle, which is very old, I was informed, but which will be new to a good many readers. It was a plane being worked on a big half-round core-box, which was built up of sections as shown, and which was held by several supports like S S, being an iron casting of webbed construction. The plane body was a right angle, with the knife K going down through so as to present a good cutting edge. The edges *a a* were cut out with a gouge for a starting point, and the plane simply shoved back and forth, cutting a good chip, and following the line of a true half circle because it couldn't help it. It was only used half way around, then reversed and the other side cut down to meet it. Every man in the shop had a little one tucked away for small work, and all declared it better than a gouge for both time and accurate work.

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Core Boxes and Core Prints.—A recent writer says: I have heard a good deal of talk about cores expanding in drying, but I must confess that I have never had a case of expanding cores come under my observation, although I have seen lots of misfit cores. This was generally due to misfit core boxes, though sometimes to careless core-making. But when I see a pattern-maker jam a pair of calipers down over a piece he is turning up in the lathe, and then when he turns up the core box caliper that with a crooked two-foot rule, I don't blame him for saying cores expand—he ought to say something. A man should caliper lathe work in wood the same as in iron, and it requires just as fine a touch to get good results. In my opinion, the two-foot rule will do to guess with, but a steel scale only should be used to measure with.

MECHANICALLY-MADE CORES.*

BY GEORGE H. WADSWORTH.

In the production of good castings nothing is of more importance than the cores. The core must not only form the inside of the casting, but must be strong enough to resist the pressure which comes upon it without springing or breaking, and at the same time be porous enough to vent freely. Many attempts have been made to produce duplicate cores by mechanical methods. These methods can all be divided into three classes: (1) Those which depend upon sifting or shovelling the sand on to a rotating arbor and then striking it off to the proper form; (2) those which depend upon the method of ramming the sand into the mould or form, either entirely by machinery or partly by machinery and partly by hand; (3) machines which form the cores by causing the sand to flow through a properly formed orifice under a steady and uniform pressure.

The first class is used very largely in the making of pipe cores and other loam cores, and for this purpose has been found very successful, as it is not a matter of ramming in the loam core, but a matter of getting the soft loam in place and properly formed for baking, the loam being so soft that it will flow readily. Hence it cannot be rammed hard in the sense of ordinary tempered sand. This same method has been used to some extent in the making of green sand cores, in which the sand is sifted or shovelled on to the arbor and swept off with a strickle board or sweep. Cores made in this way, either from green sand or loam, always require some facing or blackening, and green sand cores are liable to be very irregular in density at different points, resulting in irregular venting and frequently with the accompanying results of scabs and bad castings. At present there is no machine in general use in this country for making small cores operating upon this principle.

Under the second class, we find a number of types on the market. For the making of short cylindrical cores a stripping core box is in quite common use. This consists of a plate having one or more holes of the required diameter, and fitted with a plunger or plungers for stripping or forcing the cores out of the holes. In this case the cores are rammed by hand, and subsequently stripped out by forcing the plunger up, usually with the foot lever. Such a device as this has two disadvantages. First, if a permanent or fixed vent wire is used, the ramming must take place about this; hence, the wire is very liable to be bent or crowded out of shape, and in drawing through the core is liable to disturb the interior. If no venting device is used, the cores are naturally ventless. Second, it is only possible to make short cores in this manner, as the surface friction would prevent the stripping or forcing of a long core from the box, and it would also be impossible to ram a long core evenly. The forcing of these cores out by means of a plunger would naturally tend to make the lower part more dense than the upper.

Other machines have been devised, in which a reciprocating plunger is used to force the sand through the form for producing a long or continuous core, but it will readily be seen that every time the plunger retreats it must leave an impression of its face upon the sand, and as more sand is crowded in front of it, a parting would naturally be formed in the core. As a consequence, a machine of this type cannot produce a continuous solid core.

The third class of machine must of necessity be fed by some device which will crowd a continuous and unbroken stream of sand through the die, and the only successful device we know of for accomplishing this is a screw and the machine is of the well-known sausage-mill type. It looks like a very simple matter to put a screw into an ordinary form and force material through a die to give it the desired form, but it must be remembered that sand is an aggregation of extremely sharp pieces of mineral matter, and, when mixed with a bond, as in the core mixture, it is neither fluid nor even semi-fluid, and as a consequence no small amount of skill has been required in

* Paper read before the American Foundrymen's Association.

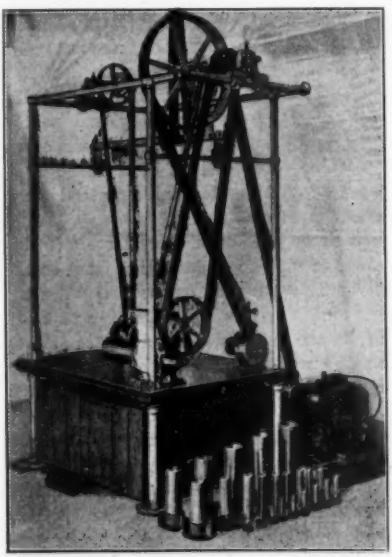
dealing with such a mixture. The successful development of a core machine of this type has only resulted after the solution of many little but inevitable problems. It is now possible to produce not only cylindrical cores but cores of any prismatic section, and of considerable length, by this means.

The question of a vent through the core is quite important. The first suggestion would naturally be to introduce a short point on the screw, and let it leave its own vent, but this point is constantly rotating, and is subject to a very peculiar scour by the sand as it leaves the screw and takes its course into the die. As a result, such a point is soon worn out of true, and finally destroyed. It has been found that better results can be obtained by having a hole through the centre of the screw, and using a stationary vent pin, passing through the screw and its shaft, and held in position from the outside of the machine. As the core is rotating, the wear upon such a pin is uniform at all points; hence it always remains in the centre and always produces a true vent, but one of the very unexpected results with this style of vent has been that the pin is worn very slightly indeed. In this connection, while considering the matter of wear, it may be interesting to state that it was natural to suppose at first that the core machine dies would be cut out very rapidly indeed by the sharp sand, but to our surprise it has been discovered that the wear of the dies is very slight, and that they maintain their size and shape almost indefinitely.

The matter of the feeding of the material into a machine of this type is of importance, as it has been found that a screw must be supplied with material no faster than is necessary to supply the amount of sand for the core being made. If the screw is buried under a large amount of sand, it simply cuts out a cylindrical form, the top becomes bridged over, and the screw ceases to feed sand forward.

This type of machine was first used for cylindrical cores, and it was found that the core, as it came from the machine, had a slight rotary motion. This rotary motion resulted in a very smooth surface upon the core, and as oil is used for a binder the result is a very smooth surface which requires no blackening or smoothing. When it was finally decided to make prismatic cores it was first supposed that the surface would not be as good as in the cylindrical cores, but by very careful arrangement of the dies it has been found that the die surface gives practically as smooth a surface in the prismatic cores as in the cylindrical.

For grinding any material, that is, for abrading its surface, with an abrasive, it is necessary that the abrasive be set in some bond which will hold its cutting edges firmly in position while they are doing the cutting. In the case of core sand in a relatively large body being forced through a machine, the individual grains are to a large extent free to move among themselves, and, as a consequence, the moment a sharp corner comes in contact with the metal face, the grain has a tendency to rotate about this point, and place itself with a flat face in contact with the metal surface. A soft die, or a relatively soft die,



THE WADSWORTH CORE-MAKING MACHINE.

is undoubtedly better for this purpose than a hard one, on account of the fact that it gives the grains a better chance and grip for turning. This movement of the individual grains results in a very smooth surface, which, when baked, is hard, smooth, and porous, and also results in very little wear on the die. A similar action undoubtedly takes place about the stationary vent pin, and greatly reduces the wear upon it.

The best cores it is possible to make in a machine of this kind can be produced from a mixture of silica sand, flour, and oil. The silica sand should be clean, sharp, and free from loam or clay. The oil used in most cases has been boiled linseed, but it is probably true that with some sands other core oils may be found valuable. The material is worked drier in this machine than in hand ramming; in fact, it would be totally impossible to make good cores by hand from the material when properly tempered for use with the machine.

The question has been asked frequently: "What lengths of cores can be made in this machine?" Thus far the efforts for the production of cores have been confined to a length of 24 in., but recently an experiment was made to see what length could be reached. The result was a core 10 ft. 6 in. long and 6 in. diam., made without any difficulty. If any firm desired to go to the expense of sufficiently stiff supports for receiving the core, there is evidently no reason why cores of considerable length cannot be made without any difficulty.

As most foundries are using hand-made cores, it may be of interest to compare the machine-made with the hand-made product. In the first place, practically all hand-made cores are rammed with some form of rod, which must of necessity result in very unequal hardness in different parts of the core, hence in unequal venting. The core mixtures necessary for hand-ramming have to be worked wetter than those for the machine, which takes longer and considerably more fuel to bake. When the core is rammed in a core box, the sand remains at the point in the box with which it first comes in contact, and is simply compressed in that position. The result is that the grains of sand on the surface of the core may lie in any position, hence cannot give as smooth a surface as is the case when the sand is forced through a die which smooths the surface. It is true that some hand-made cores are used without blackening, but in most cases blackening is necessary. I believe that with the proper selection of core mixtures, blackening can be dispensed with on practically all small machine-made cores, such as can be made with a machine of the type referred to.

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A PATENT ON CEMENT.

Mr. M. F. Wilkins, of Hammersmith, has just applied for a Patent (No. 1941, of 1904) for a cement for filling spongy castings. The cements consist of a mixture of iron or steel borings or filings, plaster of Paris, and powdered gum, such as gum arabic. Foundry black or other suitable colouring matter is added to give a dark appearance. Suitable proportions are 16 parts of iron or steel borings, 8 parts of plaster of Paris, 2 parts of powdered gum, and ½ part of black. To use the cement, it is made into a paste by the addition of water and filled into the defective casting.

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The production of coke in America in 1903, including the production of coke from by-product or retort ovens, amounted to 22,555,000 tons, of 2,240 lbs., showing a decrease of 125,000 tons on the previous year.

Sand Required for Iron and Brass Castings.—The consumption of sand per ton of 2,000 lb. in the production of iron and brass castings is given as follows:—Iron castings, average of 6,777 tons of castings made, equal .191 ton of sand per ton of castings; brass castings, average of 117 tons of castings made equal .56 ton of sand per ton of castings.

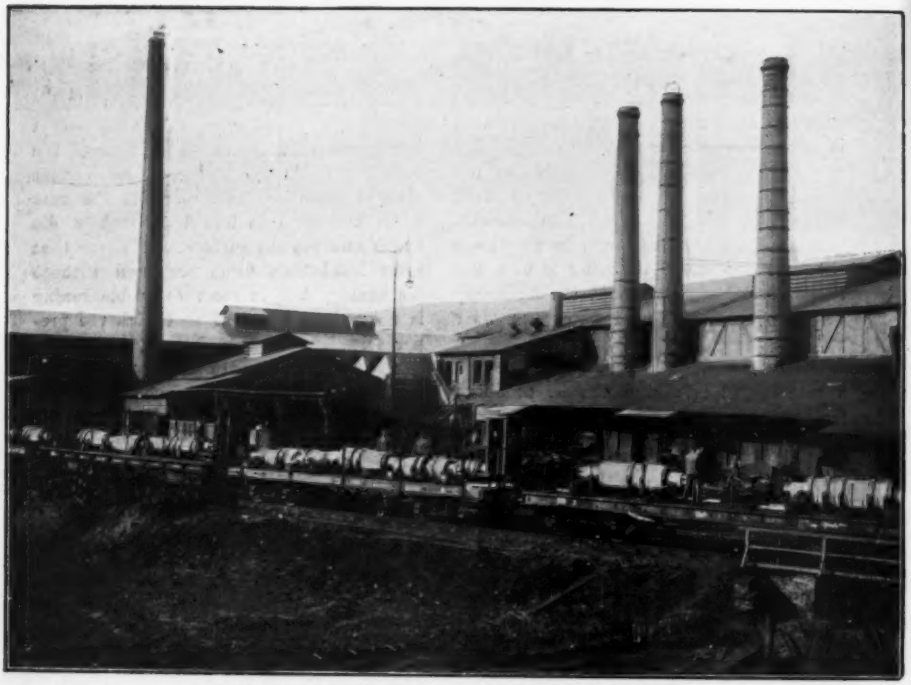

FIG. 1.—GENERAL VIEW OF KOLSCH & CO.'S FOUNDRY.

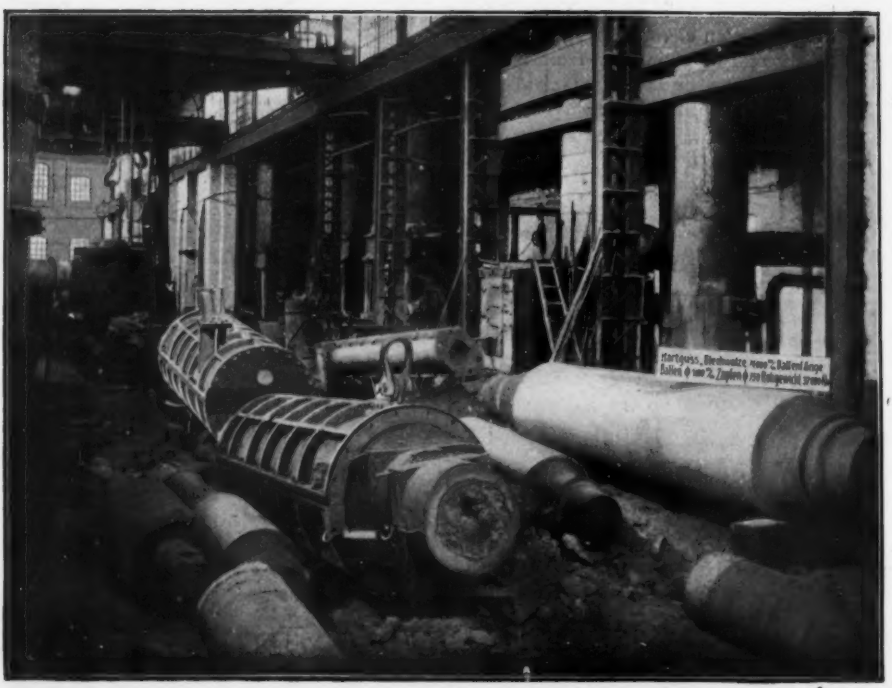

FIG 2.—INTERIOR OF FOUNDRY, MESSRS. KOLSCH & CO.'S WORKS.

A GERMAN ROLL FOUNDRY.

Up to a very few years ago, practically all the rolls used at the iron and steel works in Germany were exported from England, but as the number of steel works increased, it became evident that this practice could not continue, and that a profitable trade awaited any firm who could manufacture rolls of equal quality. Experiments and trials were, therefore, made to obtain a full knowledge of the mixtures and methods of manufacture employed by the Staffordshire roll makers, who had deservedly won such a high reputation, and for this purpose hundreds of analyses and micro-photographs were made of the rolls imported from the leading English makers. In the year 1893, the works of Messrs. Kolsch & Company were founded, and commenced the manufacture of rolls in large quantities in 1894, since which date their record has been one of continual progress. From an output of 3,000 tons per annum in the first year, their output has increased until it is more than five times this quantity, and not only are they supplying the armour plate and other rolling mills in their own country, but they are exporting considerable quantities. Unfortunately, German rolls have been delivered to some of the largest firms in this country for girders, angles, sectional iron, and thin plates, both rough and completely finished ready for working. In view of the generally higher price of pig-iron in Germany, it is obvious that this can only be done by the utmost care having been exercised in designing the works and by the employment of the most up-to-date appliances and highest technical skill in manufacture, as it must be admitted that in spite of the disadvantages in some cases of old-fashioned, badly lighted foundries, devoid of labour-

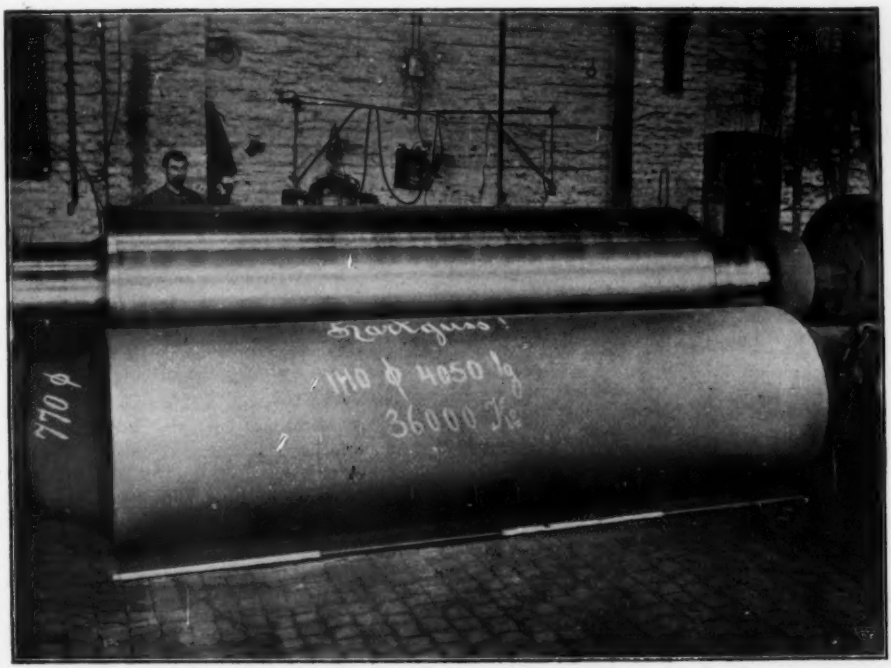

Fig. 3.—Finishing 44-in. Rolls at Kolsch's Works. Weight of Casting, 36 tons. Weight of Finished Rolls, 33 tons.

saving and other appliances, the English roll makers continue to turn out rolls of excellent quality. The illustrations show, to a certain extent, the character of the works whose competition our manufacturers have to face, and offer an object lesson to English makers as to the lines that are found necessary to meet competition.

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PIG-IRON IN ITS COMMERCIAL ASPECTS.

BY F. M. THOMAS.

(Continued from Page 100.)

WHETHER it will ever be possible to grade and number pig-iron according to its actual analysis is, to say the least, doubtful, since the mode of casting, rate of cooling, and other conditions have so great an influence on the physical properties and structure of the metal, but certainly, if a method of grading resembling that practised in America, but carried to a somewhat further extent, could be adopted, it would save a deal of trouble, and iron-founders would know exactly what to expect in any particular number of pig-iron.

At the present time, if we take half a dozen No. 3 foundry pig-irons, we find that they often differ widely in chemical composition, not only in the elements typical of their district, but in regard to silicon and carbon as well:—

Typical Analyses of No. 3 Foundry Irons.

—	Staffordshire.		Derbyshire.		Northampton	
C.C. ...	.07	.4	.6	.3	.4	.15
G.C. ...	3.6	2.7	2.5	3.2	3.2	3.0
Si. ...	2.6	2.9	3.3	2.7	3.4	3.0
Mn. ...	.4	2.3	.25	.9	.4	.2
P. ...	.9	1.0	.6	1.4	1.2	1.3
S. ...	.05	.04	.08	.04	.04	.02

With a normal proportion of other elements, pig-iron which contains upwards of 1.25 per cent. silicon is grey iron, as with this content of silicon much of the carbon present in the iron separates out into the graphitic state. Grey iron is determined by the percentage of silicon and graphitic carbon it contains, and since the greyer the iron the more money it realises, blast furnace managers naturally endeavour to get iron out of their furnaces as grey as possible. The reduction in price for each grade of iron from No. 1 to No. 3 varies with different classes of iron, the cheaper the quality the smaller the reduction, but usually the difference ranges from about 3s. per ton for each number in Scotch and similar irons, down to about 1s. or 1s. 6d. per ton for some of the Staffordshire, Derbyshire, and Northamptonshire brands. Many makers of foundry pig-iron, who are also themselves iron-founders, sell much of the iron they produce, and buy cheaper brands for their own consumption. This, of course, happens in cases where the pig-iron they make is better and more valuable than actually required in their own foundries.

Relative Values of Pig-Iron.

"Cinder" pig-iron usually costs from 1s. to 2s. less than "part-mine," and the latter about 15s. per ton less than "all-mine" iron. Scotch pig-iron generally realises about 6s. or 7s. per ton more than Cleveland pig, whilst hematite pig is worth from 2s. 6d. to 5s. per ton more than Scotch pig-iron, according to the fluctuations of the market. Cold blast pig-iron is chemically purer than hot blast. The graphitic carbon is chiefly in the finely divided state, as temper carbon, and the iron is much stronger than that produced by hot blast. Cold blast iron is expensive on account of the much greater consumption of fuel used in its production. It sells for about 25s. per ton more than the best "all-mine" brands, and is now only used for high-class castings which require to be of special quality, strength and toughness.

Selection of Pig-Iron.

The extreme range in design and strength of different castings and the varying nature of engineers' specifications and requirements, render the selection of pig-iron for foundry purposes a matter of considerable importance—both chemical analysis and appearance of fracture, may, when considered separately, be misleading as regards the physical properties or characteristics of the

iron, and a single pig of iron broken in several places may present different appearances at each fracture, and may also be of different chemical composition, particularly in regard to the percentage of silicon and combined carbon. In steel-making the chemical composition of the pig-iron may determine its suitability or otherwise without reference to fracture, but in iron-founding the analysis and physical properties of the metal must be studied together, in order to obtain sound castings, such for example as will tool easily, present a good finish, and posesss strength and toughness.

For small and thin castings requiring machining, a mixture of soft irons should be used, such as will run fluidly and not chill. The thinner the castings, the larger the quantity of silicon required in the iron, since silicon, like phosphorus, increases the fluidity. Very little sulphur is permissible in small castings on account of its tendency to produce blow-holes and make the castings hard, and as the percentage of this element increases in melting, due to absorption of sulphur from the coke, whilst the proportions of silicon and manganese decrease, there should not be more than about 0.05 per cent. sulphur in the iron to begin with. In large castings a proper proportion of sulphur is useful to give the iron a close grain, and enable it to machine to a good surface. In making light castings, such as grates and stoves, where little or no machining has to be done, and where good, clean, sharp castings, frequently ornamental in design, are required, pig-iron containing up to 1.5 per cent. phosphorus is an advantage.

For hollow-ware making a mixture of soft, fluid running irons, such as will produce castings with a fine grain and easy to machine, are essential, and for this purpose the iron produced in the Leicestershire district and at some of the Staffordshire furnaces is especially suitable. Pig-iron for making vats in which soluble metals are dissolved by acid, as in gold refining, should have a very fine and close grain, and it has been stated that iron containing about 3 per cent. phosphorus tends to resist the action of sulphuric acid, but always a close-grained iron is required for this purpose.

Grades of Swedish Pig-Iron.

Hematites and Swedish grey pig-irons are chiefly used in the foundry to improve the quality of the mixtures and to impart strength and toughness to the castings, but the chief objection, especially in the case of the Swedish iron, is its high price. Swedish charcoal iron delivered to the Midlands costs from £5 to £6 per ton, or nearly £1 per ton more than the best English cold blast pig-iron.

This Swedish charcoal foundry iron is usually made in four grades;—No. 1, very soft; No. 2, soft; No. 3, medium hard; No. 4, hard. Nos. 1 and 2 brands have a tensile strength averaging 16 tons per square inch on a $\frac{5}{8}$ in. square test bar, whilst in transverse strength a bar $1\frac{1}{2}$ in. square by 8 in. long, on supports $4\frac{3}{4}$ in. apart, required a tup 40 lbs. falling 20 in. to break it. Nos. 3 and 4 have an average tensile strength of $14\frac{1}{2}$ tons per square inch on a $\frac{5}{8}$ in. square test piece, and a fall of 21 in. was required for the tup to produce fracture. Good English foundry irons are usually made from a mixture of ores of which a proportion is hematite, and where the local ores are of rather poor quality, as much as 30 per cent., or even 50 per cent. hematite ores are included in the charge.

Tests of Foundry Irons.

A mixture of close Nos. 3 and 4 English foundry pig-irons containing combined carbon, 0.73 per cent.; graphitic carbon, 2.52 per cent.; silicon, 1.80 per cent.; manganese, .34 per cent.; phosphorus, 1.32 per cent.; sulphur, .14 per cent., gave the following tests (average of five):—

Compression: On test bar, 1.3 in. dia. by 2 in. high, 57.31 tons per square inch.

Transverse: On test bar, 2 in. by 1 in. (supports 3 ft. apart), 25.97 cwts., deflection 0.3 in.

Tensile: On test bar, 1.34 in. square, 10.42 tons per square inch.

The fractures in each case were sound and close grained.

Tensile tests of bars cast from single brands of foundry pigs vary considerably,

within a range of 6 to 10 tons per square inch ultimate tensile stress, but from mixtures of irons made of two or three brands and a proportion of scrap, tensile strengths of 10 to 12 tons can readily be obtained, whilst with special qualities of pig-iron it is possible to get bars which will stand from 14 to 16 tons per square inch tensile.

Cylinder Pig-Iron.

For locomotive and marine cylinder castings, and other special purposes where it is absolutely necessary that the castings should be hard and close-grained, free from pin holes, so that they will machine up to a very fine surface and possess great strength and wearing properties, pig-irons of special quality are produced. The grades most commonly used are hard Nos. 4 and 5, and sometimes No. 6, according to individual requirements. Pig-iron of this description, when fractured, usually has a light grey colour, a particularly fine grain, and is very dense. Uniformity of chemical composition is a most important feature in iron used for cylinders and similar castings. Cold blast pig-iron is better than hot blast for these purposes, and the irons should be mixed so that the castings will contain from 1 per cent. to 1.25 per cent. silicon. These irons require to have a low content, both of phosphorus and sulphur, to prevent segregation. Manganese should not exceed about 0.75 per cent., as high manganese increases the contraction, renders machining difficult, and decreases the tensile strength. In many cases refined irons, made from a mixture of specially selected pigs, are found to give very good results in cylinder castings, whilst latterly old ingot moulds from steel works have been broken up and re-melted for the production of closed-grained pig-irons for cylinder making. As these moulds are originally made from hematite iron, it will be apparent that a superior quality of pig-iron can be made from them. In the re-melting the percentage of silicon decreases, and a very close-grained, hard iron results. Iron of this description, when mixed with suitable proportions of grey foundry pig of proper chemical composition, together with a quantity of cylinder scrap from a previous cast, gives a tensile test of from 14 to 16 tons per square inch, and transverse test of over 35 cwts. on a 2 in. by 1 in. test bar 3 ft. between supports. To obtain uniform hardness in castings is a matter of extreme importance, especially since the advent of high speed tool steel, as the maximum speed attained in machining is limited by those which are most difficult to machine. Mr. Keep's testing machine has served a very useful purpose in this respect, as has also his silicon testing apparatus. By the aid of the latter it is possible to tell—by the simple operation of casting two test bars and measuring the contraction—what is approximately the percentage of silicon in the iron. When the castings are satisfactory, it is only necessary to continue the same shrinkage each day, and the iron will be of uniform quality. If the shrinkage is higher than is required, the silicon in the iron should be increased, whilst if lower the silicon should be decreased. A variation of other elements would, of course, change the actual percentages necessary to produce certain definite contractions. Testing for transverse and tensile enables foundry managers to determine what mixtures of iron are most suitable for various purposes, and often shows that less costly brands of pig-iron may be used than those commonly supposed to be essential to obtain certain results.

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THE GREAT HEATH FOUNDRY COMPANY, of Coventry, is being offered for sale by private treaty.

THE PREMIUM SYSTEM.—After an enquiry extending over several months, the Engineering and Shipbuilding Trades' Federation, composed of twenty-four different Trade Unions, has issued a report totally condemning the premium bonus system as "uneven in operation and harsh and unjust in its application, creating jealousy and ill-feeling in the workshops, and because it has been the cause of more discharges than any strike in the history of the engineering trade, while it is in reality a return to the degrading task-work system."

THE MANUFACTURE OF STEEL CASTINGS.*

BY W. A. HERRON.

In all departments of engineering activity the trend of the times is strongly in the direction of increased power and strength, that greater loads may be drawn, heavier burdens carried, higher speeds attained, and increased output secured, all for the purpose of saving time, or lessening the cost of production or transportation. To secure the necessary increase in strength, to resist the growing strains of service, without at the same time unduly increasing the size and weight of the parts, the engineer has substituted steel for iron castings, and this substitution is going on in all directions wherever a combination of lightness and strength is deemed essential.

The effect of this substitution is more apparent when we consider that the tensile strength of cast steel is from three to four times as great as that of good cast iron. And this is not the only advantage possessed by the steel, for cast iron is more or less brittle, and offers but feeble resistance to fracture from shocks; while steel, particularly if properly annealed, offers great resistance to failure from that cause.

Methods of Moulding.

On account of the high temperature of the molten steel as it is run into the mould, the latter must be made of a very refractory material. The material used in dry sand moulding is a pure silica sand which is mixed in the sand mill with fire clay and molasses water to give it a bond. This mixture is used for the face of the mould, *i.e.*, the part that comes in contact with the casting, and back of this facing "heap" sand, or sand from old moulds, is rammed. After the mould has been completed it is coated with a wash consisting of ground flint, molasses and water, to give the casting a good surface. It is then taken to the oven and thoroughly dried. From the oven it goes to the casting floor, where the cores are set, the moulds closed, and the metal poured. The baking of the mould makes it very hard, and great care must be exercised to prevent the casting from checking, even if the composition of the steel be good, particularly in the case of castings having thin sections, or when, by reason of the design, strains are likely to be created due to unequal cooling. Several precautions may be taken to prevent checking, among which are the cutting of thin slits at the proper places in the mould into which the steel runs, forming brackets which set quickly and strengthen the casting while it is cooling; the placing of iron rods in those places in the mould where strains will come in cooling; the cutting away of sand in the mould, and the filling of the space so formed with cinders or sawdust, so that the mould will yield when the metal is contracting around it; the filling of the centre of large cores with cinders or sawdust to soften them; the chilling of the steel by coming into contact with metal chills inserted into the mould, or with nails driven plentifully into the mould for the same purpose; the designing of the casting in such a way as to, as far as practicable, avoid undue variation in the thickness of the section of its different parts. Sometimes water is run through large cores, holes being left for the purpose, to cool the inside of the casting at the same time as the outside. In order to ensure sound castings, a sufficient number of feeding heads of good size should be used to permit the gases formed in the mould to escape and keep the mould full as the metal settles in cooling. In some cases it is well to tip the mould—*i.e.*, to raise one end higher than the other to force the gas out at the top, as the metal rises from the lower end where it enters, and to ensure the mould running full of metal.

After the casting is shaken out of the mould it goes to the cleaning room, where the sink heads or gates are cut or broken off. The sand adhering to the casting is then removed; the casting is trimmed and ground; and is ready for shipment. If it is to be used in a locomotive, or bridge, or some other place where it will be sub-

* Abstract of paper read before the Railway Club.

jected to great strains or shocks, it should be thoroughly annealed to eliminate internal strains and to increase its ductility. If resistance to wear be the quality desired in the steel, annealing will not improve but more likely injure it.

Small steel castings and castings of light sections are sometimes made in "green" moulds, *i.e.*, in moulds that are not baked. This method has the advantage of being somewhat cheaper, and because the moulds are soft and yielding, internal strains are not so likely to be created, as in the harder, dry moulds, but castings so made are not so free from blowholes as those made in the dried moulds, and are therefore not so satisfactory, particularly if they are to be machined, as the finishing process discloses the defects not otherwise apparent.

Inspection.

The inspection of steel castings as at present practised leaves much to be desired. One inspector, using discretion, may accept a casting having slight external defects marring its appearance somewhat, perhaps, but impairing its serviceability but slightly, if at all. Another, inspecting the same casting, fearing the criticism of his superior, will insist upon perfection and reject the casting. In one instance in the experience of the writer, a railway inspector rejected a lot of castings for external defects, in most cases scarcely discernible with the naked eye. An appeal was taken to his superior, who made a careful personal inspection of the castings, and accepted practically all of them. In another instance, a lot of bridge castings were accepted at the makers' works, and, subsequently, a number of them were rejected at destination. The bridge company would have accepted the rejected castings, but the engineer of the railway company would not receive them. There were thus four different inspections made, with alternate acceptances and rejections.

No reputable manufacturer will object to any reasonable inspection, but when a casting is once accepted it should not subsequently be rejected unless for defects developed during the process of finishing, and which render the casting unsafe to use.

Manufacturer and Customer.

It is to the mutual advantage of the manufacturer and his customer that castings shall be furnished of a grade best suited to the use to which they are to be put, and to that end there should be earnest co-operation. If the manufacturer be informed as to the requirements in any case, he may make the steel a little softer or a little harder than the average, to suit the special conditions existing, and he will know whether or not the casting should be annealed. If he know where the strains of service are to come, he will be able to take especial precautions to have the vital point of the casting solid. In some instances castings must be turned out so close to given sizes that a little too much rapping of the pattern in the mould will entail extra expense for machining, or perhaps cause the rejection of the casting if it must fit in place without machining. If the founder be cautioned as to the requirements in such cases he can perhaps avoid the difficulty, or, with a little chipping and the use of rough gauges, correct it and thus prevent complaints and dissatisfaction on the part of the customer. If every pattern sent to the foundry were plainly marked so as to show what parts of the casting are to be machined it would be a guide to the foundryman, who can take precautions accordingly. An occasional visit of the buyer to the foundry and of the manufacturer to his customer's works should result in good to both through the familiarity each would gain with the other's work and methods.

Everyone should profit by his failures. So when a casting fails in important service the cause of failure should, if possible, be ascertained. If it be due to any weakness of the casting it should be known so that a stronger one may replace it, or perhaps the design may be improved. The broken parts should be preserved so that the maker as well as the user may make such tests as he may desire. When defects develop in the process of finishing which cause the rejection of a casting, the manufacturer should cause the casting to be returned for inspection before a new one

is made, or if this be impracticable because of insufficient time, a sketch showing the location and nature of the defects should be furnished him, in order that he may avoid a repetition of the trouble in making the new casting. As an aid to such investigations all important castings should bear the manufacturer's mark for the purpose of identification. In cases where the foundry stamp or mark is obliterated in the process of finishing, the casting should be restamped in the shop.

As a result of unpleasant and costly experiences with steel castings in locomotives some very intelligent and experienced railway engineers had reached the conclusion that some better material was imperatively needed as a substitute for steel castings, particularly for frames and wheel centres. If the cause of failure had been ascertained in each case it would doubtless have been shown that if the material was not bad, the castings were of poor design, or they had not been treated in the foundry in such a manner as to give the best results.

The buyer of steel castings who changes with every wind, now buying from one foundry and then from another, looking always for the lowest price, is not the one who may expect the best of service. Co-operation in such a case is impracticable. The expectation of a continuance of patronage is the incentive needed by the manufacturer to excite him to his best endeavours. Familiarity with his customer's requirements enables him to better supply that customer's wants, and such knowledge comes through length of service. In such important service as in locomotives, where a broken part may cause loss of property and endanger human lives, the first consideration should be safety, and the constant endeavour should be to secure not the cheapest, but the best.

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Edgar Allen & Company, Limited, of the Imperial Steel Works, Sheffield, recently supplied the Tropenas steel plant for the Jamalpur Workshops Foundry, India. Messrs. J. Reid & Company contracted to supply the necessary materials for the steel foundry.

HINTS ON BRASSFOUNDRY.

In a paper by Mr. John F. Buchanan, of Sydney, New South Wales, formerly of Glasgow, read before American Foundrymen's Association, the following remarks are made:—

In figuring a mixture for a brass alloy, if old metals are used, it is customary to make an allowance for volatilization of zinc, say, from .5 to 1.0 per cent., according to bulk, but with alloys containing over 8 per cent. tin, the loss of tin on remelting would be nearer .25 per cent. The great secret of good mixing is to avoid "soaking," and adopt uniform grades, making castings and runners according to grade number and keeping separate bins for each. If much old metal is used in making the lower grades, half worn crucibles should be used, the newer pots being reserved for melting the cleaner metals. All metals should be charged into crucibles in the vertical position to avoid wedging and other dangerous contingencies.

Skimmings and furnace ashes should be ground, washed and melted down by themselves, for mixing with known proportions of other metals. Borings should be classified and used in the first charge of metal to act as a cushion and to assist in the reduction of the solid portions. I have noticed that borings of almost any of the alloys *are more fluid when remelted* than the original mixture. Indeed I have often taken advantage of this peculiarity in running thin castings of large area, also in "burning" thick sections economically.

Chaplets for finished brass work should be cast from the same composition as the castings. A convenient form of chaplet is the girder shape, shown in section at Fig.

Chaplets for Brass Founders.

1. These can be cast in long sprays of the various thicknesses and cut off as required. For heavy castings, copper springer, Fig.

2, or stud chaplets, Fig. 3, will be found to give complete satisfaction. Moulds should not be poured if the metal is not in perfect condition for casting; it is better to lose the cost of melting than to risk the cost of remoulding and machining.

Skin-Drying.

Many small moulds for brass are skin-dried previous to being cast. An "industrial railway" from the moulding stalls to the drying stove is a great convenience, the moulders need not handle the flasks except when making or closing the moulds. I have often been struck with the difference in the weight limit of green sand castings in cast iron and in brass. Moulds for cast iron are generally made from more porous material than moulds for brass; molten iron has a higher temperature than brass, and yet it is possible to make a heavier and cleaner casting in green sand with the former. To get over this difficulty, several large brass foundries on the Clyde skin-dry heavy green sand moulds by saturating them with naphtha and setting them alight. When the naphtha has completely burned off, these moulds, which may represent castings weighing up to half a ton, are closed and immediately cast. I mention this as a unique example of heavy green sand work suitable for castings of large area and medium depth. Properly fitted flasks, an orderly casting floor, and a well-furnished cleaning room are business-like signs in an up-to-date brass foundry. Further, your true brass founder likes to see the skin of his castings; he admires the ruddy complexion; he is fond of rich tints and *no trimming*. The scratches of a file or the marks of chisel on a good specimen annoy him. As only a few of the alloys are really improved in appearance by an acid bath, I hold that the advantages of pickling are debatable—much depends on the pickle and the duty of the castings. With good metals pickling is an unnecessary process; with poor mixtures, it is sometimes an unfriendly one; and I make it a rule never to pickle castings intended for hydraulic tests.

Blowing out cores is another practice which is sometimes overdone. Unless with castings of about equal thickness, or with intricate cores, the small advantage gained by being rid of internal dressing could be equalised by closer attention to the core sand and fettling departments, and the castings would be free from cooling strains.

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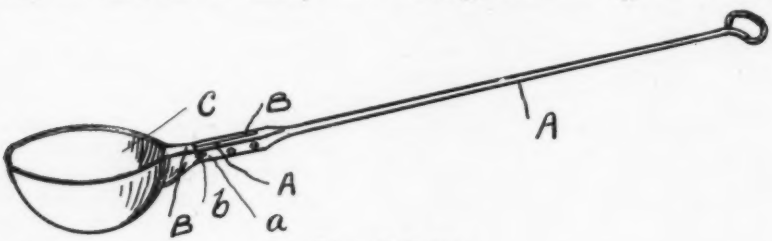
NEW LADLE.

Mr. G. Carroll, engineer, of Langside, has just taken out a Patent (No. 1931, of 1904) for a foundry ladle. This invention is designed to render the handles of foundry ladles interchangeable without decreasing their strength. On the appended drawing, which is a copy of the one attached to the inventor's specification, the handle is shown divided into two parts A, B; the part B next to the bowl C being short. Each part for a short distance from its end is of half the thickness of the handle and is formed with a pointed end or wedge *b*. These wedges engage correspondingly shaped recesses *a* so that when together the two parts form a square handle of full thickness. The two parts are bolted or otherwise secured together as shown.



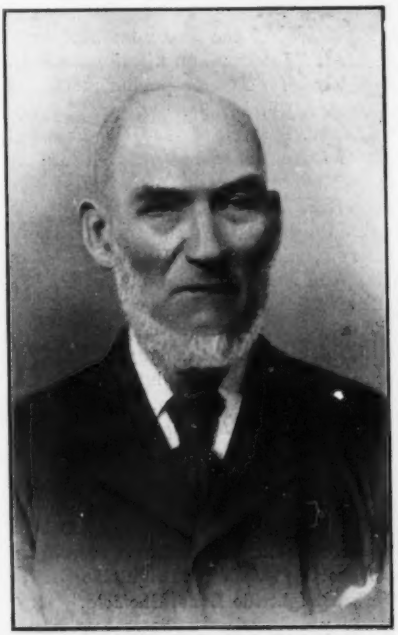
Carroll's Ladle.

SCOTTISH TRADE NOTES.

FROM OUR OWN CORRESPONDENT.

It is a significant fact that in the autumn months there has been no change for the better in the Scottish ironfoundry trade. It generally happens that however quiet business may be in the summer months, a decided improvement can be anticipated in September and October. This year, however, the rule in this respect has not held.

There is in the Falkirk district a number of foundry employés still working, though



Mr. William Balloch.

of advanced years, and whose time of service dates back to the period of the Crimean War, when shot and shell was manufactured in Carron and Falkirk foundries for exportation to the Crimea. Two of these old veterans have just been honoured by their fellow-workmen in Falkirk. The first was Mr. A. F. Thomson, Chairman of the Falkirk Parish Council, and a Justice of the Peace for Stirlingshire. Mr. Thomson, who has been a gratefitter in Falkirk Foundry, has just retired from active work after 59 years' service in these works. During 50 of these years he has held the position of foreman gratefitter. His fellow-employés met and presented him with a combined writing-desk and table as a token of regard.

Another veteran foundry worker in Falkirk who has also just had well-merited honour paid him is Mr. William Balloch, whose portrait we give.

A largely-attended social meeting, held under the auspices of the Falkirk Branch of the Associated Ironmoulders of Scotland, was held a week or two ago in the Co-operative Hall, Falkirk, to do Mr. Balloch honour. The meeting was held to mark the interesting occasion of Mr. Balloch having just completed his 50th anniversary as a member of the Society.

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MIDLAND NOTES.

The metallurgy section of the Birmingham University is producing excellent work, and the course of practical lessons given in its metal workshop at Bournbrook cannot fail to have beneficial results. The teaching received should be of untold productiveness, and the students may be expected with confidence to become men of new ideas as regards the mixing of metals and the general use of ironfoundry tools and appliances. The number of pupils is increasing by leaps and bounds, and agitation is now on to appoint extra professors.

Mr. James William Brookes, Managing Director of J. W. Brooks & Co., Limited, Ironfounders, Round's Green, Oldbury, has met with a sad bereavement in the loss of his son, Herbert Henry. On the 22nd of September, as a large bed-plate was about to be cast, a ladle containing some 1½ tons of molten iron from some unexplained cause toppled over, and the metal began to flow over the floor of the foundry near where the deceased was standing. He jumped to avoid it, and in doing so fell down into it. He, however, managed to escape into the yard, and, in his agony, leapt into a pool of water. He was pulled

out and conveyed to his father's house, which is on the premises, and after lingering, died on the 26th ultimo.

Mr. Harry Davenport, who for many years past has acted as manager to Messrs. John Harper & Co., Ltd., Albion Works, Willenhall, has resigned that post.

We regret to announce the death of Mr. John Wood, 64, Ironfounder, of The Woodlands, West Bromwich. The deceased, owing to his horse slipping in Lawley Street, Birmingham, was thrown out of his trap. Mr. Wood was the senior partner in the firm of Messrs. John Wood & Son's Great Bridge Ironfoundry, and was exceedingly well known for his genial and good address. He was a practical man, and ever ready to impart knowledge to younger men. His unfortunate and somewhat untimely death is lamented by a large circle of friends.

Some of the ironmasters of the Midlands have of late been using in their rolling mills rolls of German make, and after giving these foreign products a fair trial have decided to rely upon those made in "good old England."

The adjourned meeting of creditors of Stevenson's Metal Company, Moorsom Street Metal Works, Newtown Row, Birmingham, was held at Birmingham, recently. The Official Receiver said that Mr. A. J. Ellis would be disposed to pay a sum of 10s. in the pound on the debts incurred in the business, but he would not, of course, be made responsible for the separate and private liabilities of Mr. Stevenson. Mr. Ellis would make it a condition that the assets of the Metal Company should be transferred to him.

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TRADE TALK.

The Renishaw Blast Furnaces have been damped down

The Ailsa Shipbuilding Company are putting up new works at Troon.

Werner, Pfleiderer, & Perkins, Limited, have removed to Westwood Works, Peterborough.

The annual meeting of the Society of German Ironfounders was held at Hamburg, on October 5.

T. Smith & Sons, Limited, of Saltley, Birmingham, have established a branch at 73, Cowbridge Road, Cardiff.

The Vulcan Iron Works, Hull, belonging to Tindall, Earle & Hutchinson, Limited, are offering for sale their machinery.

Messrs. Yarrow & Company have under consideration whether the works of the company should be removed to the North of England.

At the Atlas Steel and Iron Works, Sheffield, of John Brown & Company, Limited, one blast furnace is at present being rebuilt.

The works of the Beaumont Machinist Company, Limited, of Birmingham, will be offered for sale by public auction on Thursday, October 27.

Mr. W. Towler, of the Globe Foundry, Water Lane, Leeds, has removed his London office to the Old Assembly Rooms, Corn Exchange, E.C.

The Staveley Coal and Iron Company, Limited, and Messrs. J. Oakes & Company, are supplying pipes to the Metropolitan Water Board.

The Eagle Foundry, Booth Street, Salford, Manchester, belonging to Messrs. John Fletcher & Sons, has been offered for sale by public auction.

Messrs. Lees, Anderson & Company's business, the Princes Dock Engine and Boiler Works, Govan, Glasgow, has been offered for sale by private treaty.

Hawksley, Wild & Company, has been registered with a capital of £20,000 in £10 shares. Office: Brightside Boiler Works, Brightside Lane, Sheffield.

The Lagan Foundry and the Boiler Works at Prince's Dock, Belfast, in the occupation of Victor Coates & Company, Limited, are to be offered for sale.

Messrs. J. B. Smith & Company, the Scottish representatives of Messrs. Gregory, Reddish & Company, have removed to 53, Waterloo Street, Glasgow.

Mr. Joseph Hill, of the St. George's Engineering Works, Derby, has an order from the Japanese Government for four flush side cold iron and steel sawing machines.

WELCH & COMPANY, LIMITED, has been registered with a capital of £1,000, in £1 shares, to carry on the business of copper and brass founders. The registered office is Redcliffe Backs, Bristol.

MESSRS. STEPHENS & COMPANY, Dinas Silica Works, Kidwelly, South Wales, have appointed Mr. F. E. Nurse, of 4, Grange Road, West Bromwich, as their representative for the Midlands.

MR. W. J. PIRRIE, chairman of Messrs. Harland & Wolff, Limited, of Belfast, has officially denied the rumour that the well-known shipbuilding firm was to be absorbed by the Shipping Combine.

SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED, in order to strengthen the position of the company in Italy, have acquired an interest in the firm of Messrs. Ansaldo & Company, of Genoa.

THE WAUNTREODA ENGINEERING WORKS and Foundry, Whitchurch, near Cardiff, have been sold for £2,250 to Mr. Philip Howard, of Newport. The sale included the fixed plant and machinery. The works cover an area of 2½ acres of land.

WILLANS & ROBINSON state that it is not possible to operate the Queen's Ferry Steel Foundry upon a sufficiently large scale to make a profit, without raising more capital. The directors are endeavouring to find a purchaser for them.

THE CARGO FLEET IRON COMPANY'S new works are now so far completed that the producing stage has been reached. The Koppers' by-product coke-ovens are working and the rolling mills will be in working condition towards the end of next year.

A DISSOLUTION of partnership has occurred in connection with Messrs. W. H. Newton, G. H. Fish, J. E. Moulton, and W. Moulton, ironfounders, of Manchester, who carried on business under the style of Newton, Fisb & Company, so far as regards Mr. G. H. Fish and J. E. Moulton.

THE AVONSIDE ENGINE COMPANY, of Bristol, have acquired a considerable acreage of land adjoining Fishponds Railway Station, Bristol, upon which they are erecting new locomotive works, of the most modern and up-to-date design. When the works are completed, they will have an output equal to about 70 main line engines and tenders per annum.

THE YORK ENGINEERING COMPANY, LIMITED, is about to be voluntarily wound up. The company was the outcome of the fusion, in 1882, of the works of Messrs. A. & J. Walker and Messrs. Close & Ayre. The company carried on a business in railway engineering work. In consequence, however, of the North-Eastern Railway Company and other companies having built shops of their own, for the execution of repairs, the decision to voluntarily wind up the company was arrived at.

MESSRS. THOMAS SUMMERSON & SONS, LIMITED, of Darlington, are building a new foundry, 209 ft. in length and 60 ft. wide. This building is to be composed of steel joists with composite roof, slated and boarded sides, and will be thoroughly ventilated and lighted by the most approved methods. In this building will be located a large coal store and overhead travelling crane for heavy work, whilst several labour-saving appliances will be installed. Adjoining the foundry will be buildings for sand-mixing plant, blowing plant, and coke and loam stores.

COMPANY NEWS.

BALDWINS, LIMITED.—Profits, £68,856.

VULCAN FOUNDRY, LIMITED.—Dividend of 6 per cent.

BABCOCK & WILCOX.—Dividend on the ordinary shares, 1s. 7 1-5d. per share.

CAMMELL, LAIRD & COMPANY.—Interim dividend of 2½ per cent. on the ordinary shares.

ASHTON VALE IRON COMPANY.—£3,484 available for dividend. Dividend of 2½ per cent.

DICK, KERR & COMPANY.—Profits, £84,171. Dividend of 10 per cent. on the ordinary shares.

COLTNESS IRON COMPANY.—Dividend of 8 per cent., and a bonus of 2 per cent. on the ordinary shares.

Glenboig Union Fire Clay Company.—Gross profit, £27,689; dividend of 10 per cent., and carry forward £2,689.

Sheepbridge Coal and Iron Company.—Net profit, £69,384. Final dividend, making 7½ per cent. for the year.

Ibbotson Brothers & Company, Limited.—Profit for the year, £18,281 18s. 3d. Dividend of 7 per cent. for the year.

John Hetherington & Sons.—Debt to profit and loss of £22,590, increasing the adverse balance brought forward to £65,092.

Willans & Robinson.—Loss of £3,345, in respect of Rugby. The loss at Queen's Ferry, after writing off £9,937 depreciation, is £25,902.

P. & W. MacLellan, Limited.—Dividends of 6s. per share, less income-tax, on both the ordinary and preference shares.

Fleming & Ferguson, Limited.—Dividend on the ordinary shares of 5 per cent, which, with the interim dividend, makes 10 per cent. for the year.

Sir W. G. Armstrong, Whitworth, & Company.—After adding £81,576 brought forward, a profit of £583,263. On the ordinary shares a dividend of 3s. per share.

Birmingham Small Arms Company.—Final dividend of 5 per cent. on the ordinary shares, with a bonus of 2s. 6d. per share; 2½ per cent. on the preference shares.

OBITUARY.

Mr. A. Pollock, agricultural engineer, of Mauchline.

Mr. H. A. Willey, of Exeter, head of the firm of Willey & Company, Limited. Age 41 years.

Mr. Edward Simpson, the senior partner of Edward Simpson & Company, engineers. Age 75 years.

Mr. James Wallace, of John Wallace & Sons, Limited, agricultural engineers and implement makers, Glasgow.

Mr. T. Holcroft, J.P., of Thomas Holcroft & Sons, Limited, Ettingshall Foundry, near Wolverhampton. Age 80 years.

Mr. W. Ford-Smith, who founded the firm of Smith & Coventry, of the Gresley Iron Works, Manchester. Age 74 years.

Mr. G. Davis, for twenty-eight years with the engineering department of the Lancashire and Yorkshire Railway. Age 61 years.

Mr. J. Peck, senior member of the firm of Messrs. J. Peck & Son, of the Borough Iron Works, Witham Town, Boston, Lincs. Age 89 years.

Mr. James Booker, of Rustlings Road, Sheffield, a member of the staff at the Baltic Steel Works, Attercliffe, of J. Beardshaw & Son, Limited.

Mr. James Clifford Morgan, of Doncaster Road, Rotherham, in his 82nd year, formerly of Morgan, Macauley & Wade, Baths Foundry, Rotherham.

Mr. Charles Crookes, senior member of the firm of Messrs. Crookes, Roberts & Company, steel converters, Argus Works, Shoreham Street, Sheffield, in his 68th year.

Mr. Joseph Burdekin, several years managing director of William Jessop & Sons, Limited, Sheffield. His son, Mr. W. B. Burdekin, is the present secretary of William Jessop & Sons, Limited.

Mr. Isaac Hill, late senior partner of Isaac Hill & Son, of Derby, makers of cold iron and steel sawing machinery, and large makers of malleable iron and steel castings. His sad death, by asphyxia, will in no way affect the standing of the firm, as his son, Mr. Joseph Hill, has for some eight years been the sole proprietor.

PERSONAL.

Mr. George Hall, the senior partner of the firm of G. & J. Hall, Hereford Street, Sheffield, has been installed Master Cutler of Sheffield.

The late Mr. Charles Gillham, iron founder, of 57, Queen's Road, Buckland, Portsmouth, left an estate valued at £11,983 gross.

FOUNDRY

On Admiralty List.

LADLES

On War Office List.

Of every Description for Iron or Steel.

Evans's Unbreakable Stamped Steel Ladle Bodies.

ESTABLISHED HALF A CENTURY.

JAMES EVANS & Co.,

FOUNDRY REQUISITE MAKERS,

BLACKFRIARS, MANCHESTER.

☞ **Send for our New Illustrated List of Steel Ladles, made in sizes from 28 lb. upwards, post free.**

Mr. J. S. Randles, M.P., president of the British Iron Trade Association, will leave England early in November for the Nile, and will be absent until the end of the year.

Mr. H. Tattersall, a member of the firm of Messrs. Wm. Smith & Brothers, was severely injured by an explosion at the company's Sun Iron Works, Heywood, on Monday.

Mr. Leslie S. Robertson, secretary of the Engineering Standards Committee, has gone to America to study the progress made in that country in the adoption of standardisation.

Mr. Hingelberg, of the engineers' department, Atlas Works, Sheffield, of John Brown & Company, Limited, has been the recipient of a presentation from the employés on the occasion of his marriage.

Mr. E. P. Martin, managing director of Guest, Keen & Nettlefolds, Limited, has been the recipient of a presentation from the employés and officials at the various works and collieries of the firm.

—o—

NEW INVENTIONS.

List specially compiled for The Foundry Trade Journal by Mr. GEORGE BARKER, Fellow of the Chartered Institute of Patent Agents, Consulting Engineer and Expert, 77, Colmore Row, BIRMINGHAM.
Telephone No. 1,300. Telegraphic Address—"Patent, Birmingham."

15,536. H. E. Newton. Improvements in moulding apparatus for casting in metal.

16,028. J. Y. Johnson. Improvements in the manufacture of steel.

16,276. W. Kaufmann & A. Bouvier. Improvements in or relating to the manufacture of steel.

*16,419. E. Engels. A new or improved process for treating steel and armour plates.

*16,448. H. Harmet. Process for refining cast-iron and in apparatus therefor.

17,241. J. M. Gledhill. Improvements in apparatus suitable for the manufacture of ingots.

18,332. W. H. Lycett. Improvements in and relating to the manufacture of metal moulding for fenders and curbs.

18,674. H. W. Annable, O. J. Steinhardt, J. L. T. Vogel, and The Tungsten and Rare Metals Company, Limited. Improvements in the treatment of nickel ores.

Applications marked * denote complete applications.

—o—

QUERIES.

This department of the Journal *undertakes the answering of queries in foundry practice and pattern making. We trust our readers will afford us assistance in answering these queries so far as possible.*

Communications should be addressed to the "Editor, The Foundry Trade Journal, 165, Strand, London, W.C.," *and must be accompanied by the correct name and address of the querist, not for publication, but as a guarantee of good faith.*

Defective Castings. — A subscriber writes: Could you kindly tell me a good flux for molten iron? I have just cast a steam cylinder on its side. I used good scrap, a little Swedish pig, and remainder Carron pig. The metal was nice and hot, and when the casting was trimmed off it was perfect from a moulder's point of view; but when tested it leaked, so I broke it up, and I find at the end nearest to the runner a mass of dross as big as the palm of my hand. The casting was fed down the riser over where this dirty place is. Could you please explain the cause?

* * *

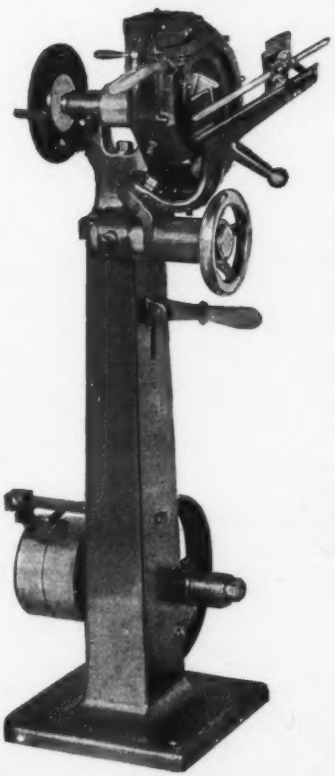
In reference to the above, "Foundry Chemist" writes:—In reply to "Cylinder," who has had trouble with a defective steam cylinder, I should like to suggest that the reason of his trouble may not be entirely due to the iron or the lack of a good flux. As your correspondent does not state the quantities or quality of irons used in his mixture, it would be difficult to say whether the resulting iron was suitable or not. Again, if the cylinder was cast on its end, and cast rather longer than required, the extra part at the top, which would contain any bad places, could be machined off. As regards a flux, cast-iron in the ladle or shank should be clean and not require extra flux. The letter does not give many particulars, so it is rather difficult to advise

A

STEADY FLOW OF WATER

WITHOUT THE NEED OF A PUMP ON

WORCESTER WET DRILL GRINDERS.



The flow is downward on to the point of the drill, so that the drip is carried off the right way without spatter.

These grinders do not require any preliminary adjustment. A newly designed lip rest automatically locates any drill within the capacity of the machine and holds it as an expert would. This enables inexperienced men to do the finest work on these grinders.

As the Worcester grinders are of excellent workmanship, and are made in 25 varieties at prices to suit all requirements, there is now no reason why you should not insist on having a genuine "Worcester."

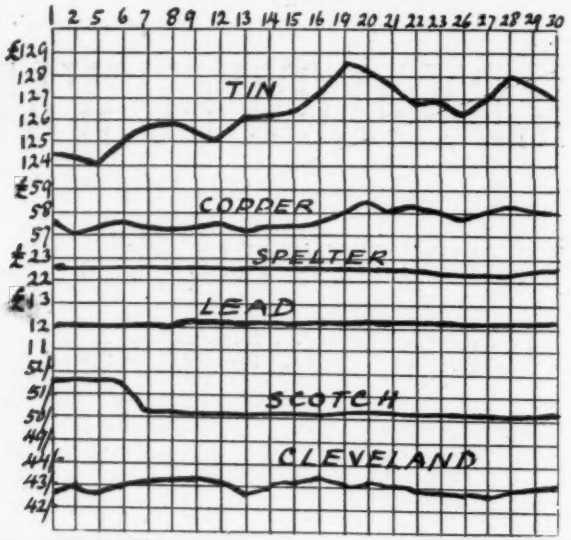
OVER 3,000 SOLD.

ALWAYS AHEAD.

J. W. & C. J. Phillips

23, COLLEGE HILL, LONDON, ENGLAND.

CHART OF THE FLUCTUATIONS OF THE METAL MARKET IN SEPTEMBER.



PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	1904.	1903.
Iron—Scotch pig warrant ... ton	..... 50 6	..... 50 0
—Middlesbro' warrants ... ... ton	..... 43/6½	..... 43/2½
—W.C. M/nos Bessemer ... ... ton	..... 53/6	..... 57/0
—Stock, Scotch, Oct. 14. ...tons	 9,524	 11,090
Copper—Chili bars, GMB ... ... ton	..... £60—£60 5	£54 12/6-54 17/6
—Stock, Europe & afloat... ... tons	13,878	 15,251
Tin—English ingots ton	...£131-£131 10	... £118-£118 5
—Straits ... ton	£130-£130 2/6	115 10-115 12 6
—Stock, Ldn. Hind and aft ... tons	 9,079	 13,489
Lead—English pig ton	..£12 5-£12 7/6	£11 5-£11 7/6
Spelter—Ord. Silesian ... ... ton	£22 17 6-22 18 9	£20 10 - £20 15
Quicksilver-(75lb.) bottle	..... £7 15	..... £8 7/6
Antimony—Regulus ... ... ton	.....£26 10—£27	..... £25 15—£26

In the Cleveland district the following are the nominal rates current for castings :—

Iron Castings.

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	7 0 0
,, 3 to 4 in....	4 10 0	to	4 17 6
,, 10 to 16 in....	4 7 6	to	4 10 0
,, 18 to 24 in....	4 7 6	to	4 10 0
Chairs	3 7 6	to	3 10 0

PIG-IRON OUTPUT.

THE IRON AND COAL TRADES REVIEW gives its usual quarterly returns as follows :—

Number of furnaces in blast for the quarter ended September 30, 1904, and estimated output of pig-iron for the nine months.

District.	Number of Furnaces in blast, Quarter ended Sept. 30.	Estimated make of Pig-iron for 9 months ended Sept. 30 in Tons.
Scotland	86	772,500
Durham and Northumberland	25	780,313
Cleveland	50	1,543,150
Northamptonshire	14	167,310
Lincolnshire ...	13	222,421
Derbyshire	24	233,700
Notts and Leicestershire	14	119,796
South Staffs and Worcester ...	16	278,712
North Staffordshire	13	183,892
West Cumberland	18	567,124
Lancashire	11	388,507
South Wales ...	19	540,796
South and West Yorks	13	193,380
Shropshire	3	72,838
North Wales ...	2	
G'oster, Somerset, and Wilts... ...	1	
Totals	322	6,064,469

SITUATIONS VACANT & WANTED.

YOUNG MAN with ten years' experience in Foundry Management, seeks situation as Foundry Manager. Used to turn over 40 tons per week. Repetition work speciality.—Apply Box 300, FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FIRST CLASS BAR IRON AGENCY Wanted in London by old-established Firm who have Office in City and keep large stock in London, E. Have good connection. Also open to represent maker; well able to compete in Plates and Sheets.—Address R., Offices of EAGLAND & Co., 165, Strand, London, W.C.

IRONWORKS MANAGER Wanted; must be thoroughly practical in every department of blast furnace work, and in getting and smelting Northampton ores. Age about 35.—Apply, stating salary required, Box 116, Offices of EAGLAND & Co., 165, Strand, London, W.C.

FOUNDRY FOREMAN required to take sole charge of a small Foundry doing eight Iron, Brass, and Gunmetal. Only those with experience of modern shops and capable of turning out the very best class of work need apply. Good salary and bonus on results to thoroughly capable man. — Apply, stating age, experience, and references, to Box 305, FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE.

FOR SALE.
One 5 tons, one 3½ tons, one 2½ tons, and one 1½ tons Geared Crane Ladles, in good condition.—Apply ALBERT FOUNDRY Co., Albert Road, Halifax.

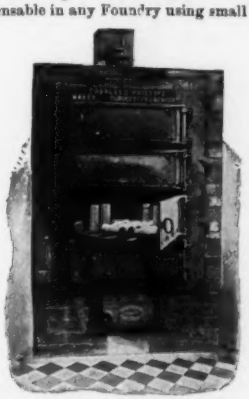
FOR SALE.
9-h.p. Stockport Engine. Two Samuelson's "J" Blowers, equal to new. Two 30 in. Cupola Shells and cast-iron fittings. Prices on application, R. HUNT & Co., LTD., Atlas Works, Earls Colne, Essex.

THE HELICAL CENTRIFUGAL PUMPS.
Wade and Cherry's Patent.
SOLE MANUFACTURERS AND PATENTEES, **John Cherry & Sons,**
Pump Works, Beverley, Yorkshire.
Tel. Address: "CHERRY, BEVERLEY"

GANISTER, CUPOLA BLOCKS, FIRE BRICKS, FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c., &c. Steel Moulders' Composition, Silica Cement.
J. Grayson Lowood & Co., Ltd.
DEEPCAR, near Sheffield.
Telegrams: "Lowood, Deepcar."

OUR PERSONAL ATTENTION AND LONG EXPERIENCE
is at your disposal, should you entrust us with the development or economical production of your invention.
Stamping in Brass, Steel, German Silver, Aluminium, Toolmaking, Repetition Work, &c.
PHILLIPS & HINE,
Toledo Stamping Works,
ASTON BROOK ST., BIRMINGHAM.

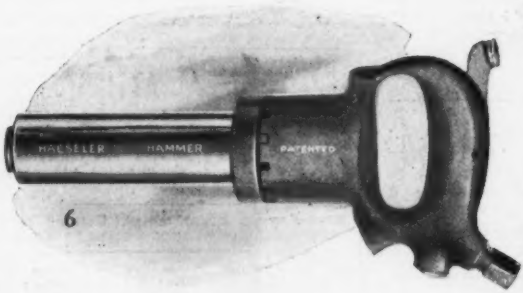
CHARLES D. PHILLIPS'
Registered and Improved
Foundry Core Oven,
Indispensable in any Foundry using small Cores.



Registered No. 356,812.
Fitted with a Slow Combustion Stove with all necessary regulating valves.
Outside Dimensions 3 ft. 4 in. by 3 ft. 6 in. by 5 ft.
Specially Reduced Price £18.
CHARLES D. PHILLIPS,
Emlyn Iron Works, NEWPORT (Mon.).

PNEUMATIC TOOLS

OF ALL DESCRIPTIONS.



HASELER-INGERSOLL "AXIAL" VALVE.

CHIPPING & RIVETTING HAMMERS.

DRILLS for all classes of Drilling and Tapping, as supplied to the leading Foundry and Engineering Firms.

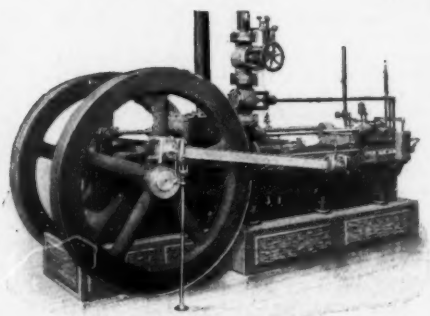
Air Compressors,

Any Capacity or Pressure.

Complete Installations quoted for.

Write for Catalogue No. 5.

Telegraphic Address: "Enyan, London."



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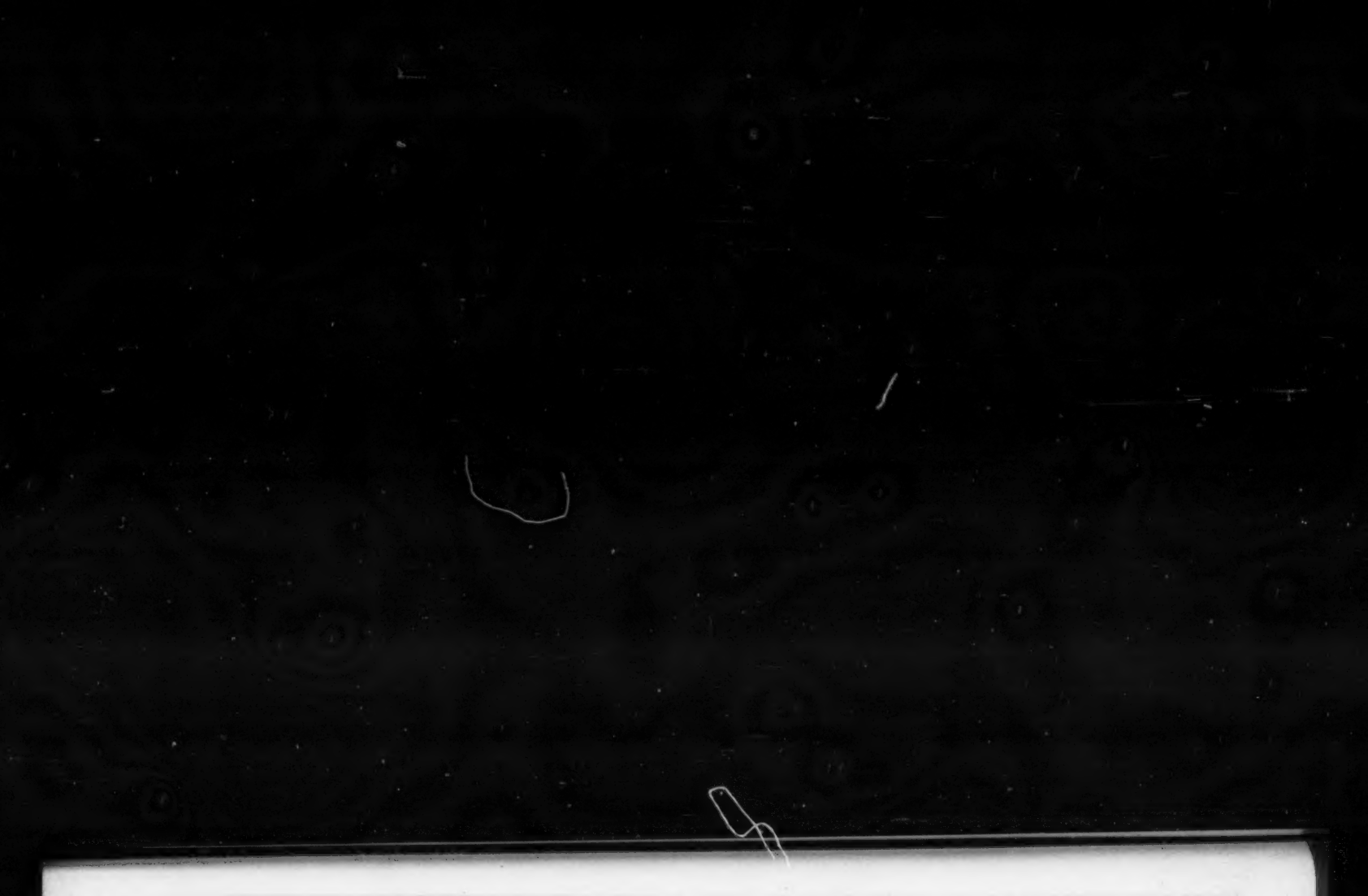
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